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M. N. FORNEY, . . . . . Editor and Proprietor.
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FROM the time of the earliest explorations the long isthmus which connects North and South America has invited by its geographical conformation the building of an artificial channel to connect the Atlantic with the Pacific Ocean. The numerous projects for such a canal, more or less feasible in their nature have, apparently, at last reached their culmination in the Nicaragua Canal, which is now actually under construction.

In view of the fact that this great interoceanic channel will probably be completed in a few years, and in view also of its great commercial importance, a full account of the canal and of the many plans and surveys which led to the final adoption of the Nicaragua route will be of much interest. Such an account, arranged in a proper historical order, has been prepared for the JOURNAL by a writer who has had access to the best authorities and who has himself taken part in some of the surveys, and the first part will be found upon another page of the present number.

A GOOD deal of progress has been made lately in the introduction of electricity as motive power on street railroads, and the results obtained in many places have been very encouraging. Part of this is due, perhaps, to the experience gained on the first electric street railroads, and part also to the fact that electrical engineers and manufacturers are now realizing a fact which unfortunately some of them seem to have forgotten at first, and that is, that thorough workmanship and good design are as essential to the success of an electrical motor as to that of any other class of machinery. We do not wish to be unduly severe upon our electrical brethren, and indeed our strictures in this respect have been much more moderate than those of some of their own number. Many of them, both engineers and manufacturers, have realized this fact from the first, and with their designs and workmanship no fault can be found; but others, unfortunately, have apparently assumed that anything which could be called a motor would answer the purpose as long as it was run by electricity; and it is to this assumption that more than one of the failures which have been counted up against electric railroads are due. While cable traction seems at present to be the most desirable for roads of very heavy traffic, there remains for the electric car a wide field in this country, and it is very desirable that its success should not be impaired by carelessness in engineering.

THE West End Company in Boston is gradually getting its lines into working order with electric motors, and the system will be extended to one line after another until all are equipped, and animal power abandoned altogether. There has been a little friction, as might have been expected, but, on the whole, the electric motors are doing very well so far as they have been put in use. What trouble there has been seems to have been caused by an underestimate of the power required in bad weather, a mistake which can be remedied.

In New York the electric motor does not seem to meet with so much favor, although plans for dispensing with horses are not wanting. The Broadway line in that city is to be made a cable road, and the Third Avenue Company will adopt the same system as soon as certain legal obstacles can be overcome. These are the two lines having the heaviest traffic in the city, and their example will doubtless have much weight with the other companies.

IN Brooklyn as well as in New York the question of rapid transit is under discussion. The new elevated lines do not serve a considerable section of the southwestern part of the city, and there is a demand for a line along Atlantic Avenue. That it is needed no one seems to dispute, and the discussion is chiefly on the point as to whether it shall be an elevated or a depressed road. The contour of the ground is favorable to the tunnel, but it would be more costly than an elevated road, and popular preference in this country is usually for the latter form.

THE city of Chicago is soon to have its first elevated railroad, work having been begun on the South Side Elevated line. According to the contracts a mile of this road is to be finished during April, and its rapid extension is promised. This line is the beginning of a system of elevated roads to accommodate the city travel, and to take the place to some extent of the surface lines, which have proved themselves insufficient to accommodate the traffic.

THE second bridge over the Mississippi River at St. Louis will shortly be in use, the Union Bridge Company having completed the new Merchants' Bridge. The moving cause of the construction of this bridge was the fact that the St. Louis Bridge has now for some years been under the control of a single railroad interest, and that a second crossing was considered necessary to accommodate the business of the city and the railroads. It will be some weeks yet before the bridge is opened for traffic, for, while the structure itself is finished, the approaches, which have been built under a separate contract, are not quite complete.

THE opening of the Forth Bridge for traffic took place at the appointed time, and trains are now running regularly over this structure, which is for the present the greatest bridge in the world.

If the present stage of engineering requires any special designation, it might be called the era of great bridges. Late improvements in material, in methods of construction and in design have enabled engineers to undertake spans

which were considered impossible not long ago, and they have not been slow to take advantage of them. Taking recent examples in this country, there are the Poughkeepsie Bridge, the Cairo Bridge and the new bridge at St. Louis; the building of the bridge over the Mississippi at Memphis has been begun, and there is a fair prospect that the bridge over the Hudson at New York will be built after a time. That it is practicable no one seriously doubts.

A second bridge over the East River between New York and some point on the Long Island shore is also among the probabilities of the near future.

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THE Ohio River has been unusually high this spring, wet weather and an early thaw having caused a flood which reached its greatest height—56 ft. 10 in. above low-water mark—at Cincinnati on March 1. There and at all the other towns on the river and its principal tributaries much damage was done. In due course the flood reached the Mississippi, and great injury to property is reported at and below Cairo. There has also been much damage from the breaking of levees on the lower river, so that the mild winter and wet spring of 1889-90 will be remembered for a long time.

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THE great dam at Walnut Grove in Arizona, which was built about a year ago, has been partially destroyed, having given way under circumstances of which no very clear account has yet been received. The dam was built in the Walnut Grove Cañon and made a very large reservoir, in which the waters of the Hassayampa River were stored up to be distributed and used for irrigating purposes. In this way a large extent of land has already been prepared for cultivation, while preparations had been made to increase the area of irrigation considerably this season. So far as is yet known the failure of the dam seems to have been due to careless and hasty work in its original construction, and to a failure to provide sufficient waste-ways to draw off the overflow in a season of unusual rainfall like the present.

The accounts of this dam at hand are somewhat contradictory. It seems to have been well designed in the first place, but the original plans of the engineer were partially set aside on account of the expense of transporting material to the location of the dam. It was what is known as a rock-filled dam, but seems to have been somewhat carelessly built, with perhaps too steep a slope on the lower face. It is probable also that the waste-weir was not built in accordance with the engineer's plans, but was made of somewhat smaller capacity than he intended; and it may also prove that too great regard was paid to economy and the convenience of the contractors. Later accounts may give a fuller explanation, but it seems certain that the amount of water brought down by the river exceeded that observed in any previous season since the country was settled, and that the failure of the dam was due directly to the pouring of a large volume of water over its crest.

The loss to the owners of the dam is considerable, but the damage and loss of life caused by the breaking of the reservoir was not very large, because the valley below the dam is not thickly settled and contains no expensive buildings. It is understood that the dam is to be rebuilt.

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THE production of pig iron continues to be very large. On March 1 there were in blast, according to the statement of the *Iron Age*, 343 furnaces with a total weekly capacity of 180,991 tons. This is an increase of 10 furnaces and 6,953 tons capacity since January 1, and of 35 furnaces and 31,216 tons capacity as compared with March 1, 1889. Several new furnaces of large capacity are nearly ready to start, so that a further increase is expected. While the stocks of iron reported on hand are large, they are not greater than might be expected, and the production does not seem to be in excess of the demand.

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THE process of railroad consolidation and absorption has been continued in the Northwest by the sale of the Chicago, Burlington & Northern Railroad to the Chicago, Burlington & Quincy Company. The Burlington & Northern, which is a line from Chicago to St. Paul, was really built to be sold in this way, but various circumstances have made it necessary to postpone the transfer until now.

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ANOTHER step in the same process is the transfer of the control of the Louisville, New Albany & Chicago Railroad to the Pennsylvania Company. This change was not expected, but was very quietly made, and did not become generally known until the annual meeting, when a board of directors in the Pennsylvania interest was chosen.

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THE Louisville, New Albany & Chicago sale practically puts out of the way one of the competing lines from Chicago to Cincinnati and Louisville. The Burlington & Northern transfer, however, does not diminish the number of competing lines between Chicago and St. Paul, but only puts one of them into the hands of a stronger company, leaving the rate problem where it was before.

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TWO cases of fast time are reported, both runs being made on the same day, March 10. On that day the Pennsylvania Railroad ran a special train from New York to Washington and return, for the purpose of carrying a theatrical company which was to perform in both cities on the same day. The train—which consisted of an engine, a combination car, passenger coach and dining-car—left Jersey City at 7.29 A.M. and reached Washington at 11.47; the total time was thus 4 hours, 18 minutes. The only stop made was in Philadelphia, where four minutes were spent in changing engines. The running time from Jersey City to Philadelphia was 97 minutes, or at the rate of 55.05 miles an hour; from Philadelphia to Washington, 157 minutes, or at the rate of 52.36 miles an hour; the total for the whole distance being 254 minutes, giving an average of 53.31 miles an hour. The return trip was in almost exactly the same time, the total time being 4 hours, 19 minutes; deducting a six-minute stop in Philadelphia, this left the running time 253 minutes, or one minute less than in the morning.

On the same day a special—consisting of an engine and one car—was run over the Bound Brook Line from Philadelphia to Jersey City in 85 minutes, or at an average speed of 63.53 miles an hour. The run from Wayne Junction to Bound Brook was made in 50 minutes, or at an average speed of 66 miles an hour.

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THE use of corrugated tubular fire-boxes for locomotives is advocated in Germany by several engineers of standing, the advantages claimed being the lower first cost of boilers, owing to their simplicity of form, and the greater strength of a plain cylindrical boiler, which will permit the use of higher pressure—this last being an especial advan-

tage in the case of compound engines. Some illustrations of the forms of boiler proposed will be found on another page. It is understood that some tests of the corrugated fire-box are to be made on the Prussian State Railroads.

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THE latest addition to the list of fast Transatlantic steamers is the *Normannia*, which was recently launched at Govan, Scotland, for the Hamburg-New York line. This ship is 500 ft. long, 57½ ft. beam, 38 ft. in depth and is registered at 8,500 tons. Like most of the large Atlantic steamers recently built, she has twin screws; each screw is worked by a triple-expansion engine with cylinders 40 in., 67 in. and 106 in. in diameter, and 66 in. stroke. Steam is supplied by nine double-ended steel boilers 16 ft. in diameter and 18 ft. long, each having eight corrugated furnaces; the working pressure will be 160 lbs.

The contract speed of the *Normannia* is 19 knots an hour, but her builders expect that she will exceed this, and that her engines will develop at least 14,000 H.P. The size of the ship is shown by the statement that she will have accommodations for 420 first-class, 172 second-class and 700 steerage passengers, making 1,292 persons in all who can be carried, besides the crew.

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THE final test of the guns of the dynamite cruiser *Vesuvius* was made on the Delaware River near Chester, Pa., March 13. The tests were for speed in firing, made with dummy shells, and for range, the latter being made with loaded shells. Both were successful, and the range reached was 6,480 ft., or 400 yards over the mile required. The fuses worked well, and the shells exploded on time.

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THE substitution of steam for compressed air in a gun intended to throw shells containing dynamite, or other high explosives, is proposed in France, the advantages claimed being the furnishing of power direct from the boiler, without the use of air-compressing machinery. The pressures usually carried in steam boilers would not be sufficient for this purpose, but the Belleville Boiler Company claims that it can furnish boilers of the Belleville type which can supply steam at a pressure of from 600 to 800 lbs., and which will be at the same time safe and easily handled. The experiment, it is stated, is to be tried by the French naval authorities.

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IN the month of March two of the new ships for the Navy were launched—the *Newark*, which belongs to the class of large, swift, heavily armed cruisers like the *Chicago*, *Baltimore* and *San Francisco*, and the *Concord*, a light cruiser or gun-boat, of a type of which the *Yorktown* is the only representative now in service. The *Bennington*, a sister ship to the *Concord*, will follow early in the present month. These two gun-boats, while they could do little in action against a heavy battle-ship, may yet be exceedingly useful vessels in service, as, for instance, on the China and other Eastern stations where our Navy finds employment in time of peace, while in case of war they could also do good service against the commerce of an enemy and as assistants to the heavier fighting ships.

The next vessel for which contracts will be let is the 8,100-ton armored cruiser, which will be the largest ship yet undertaken for the new Navy, though her fighting power will be somewhat less than that of the *Texas*.

Setting aside the special coast-defense vessels or floating batteries, however, there is some doubt whether it will be advisable to go very much beyond this. The heavy battle-ships of England, France and Italy have not been entire successes, and there is high naval authority for saying that it is still an open question whether quickness in manœuvring may not be an offset to mere weight of armor and guns—in other words, whether, when modern naval constructions come to the test of actual battle, the victory will not remain with the swift rather than the strong.

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## THE GEOLOGICAL SURVEY.

THE topographical work of the United States Geological Survey continues to be pushed with much energy, and the record for the season which closed in December last is an excellent one, in spite of delays caused by much unfavorable weather. The assistants of the Survey were employed in no less than 23 States and territories, and the entire area covered by their work during the season was about 77,000 square miles. The office work was also well kept up, and the issue of the atlas sheets of the new surveys has been made promptly. The excellence of these maps is well known, and their mechanical execution is of a high order.

In the East the surveys have included 1,500 square miles in Maine, 450 in Vermont, 2,700 in Connecticut and 2,000 in Pennsylvania, the work in the last-named State having been chiefly in the anthracite coal region. The results of these surveys appear in 30 atlas sheets. These are all of uniform size, and for the Eastern States are on a scale of 1 : 62,500, with a contour interval of 20 ft. For the Central and Western States the maps are on a scale of 1 : 125,000, and each map includes about 1,000 square miles.

In the Southern Appalachian Mountain region the surveys extended through Kentucky, West Virginia, Virginia, Tennessee, North Carolina, South Carolina, Georgia and Alabama, covering about 12,000 square miles. Maps of this region are in much demand, on account of the rapid development of its mineral and other resources now in progress and the construction of numerous railroad lines through it.

In the Southwest a large force was employed, about 12,000 square miles having been covered in Kansas, 3,000 in Arkansas and 6,000 in Texas. The country surveyed in Arkansas was in the Ozark Hills, a district which has been heretofore almost unexplored.

In the Northwest about 700 square miles were surveyed in Wisconsin and 2,000 in Iowa. A special detailed survey of the iron range in the Upper Peninsula of Michigan has been begun, and was about half finished at the close of the season.

Perhaps the most important special work now in progress is the survey of the arid region of the Far West, which has been undertaken as a part of the irrigation survey. Last season's work covered 5,000 square miles in California and Nevada; 2,000 in Idaho; 2,000 in Montana; 4,000 in New Mexico and 24,000 in Colorado, making a total of 37,000 square miles in the belt which is chiefly to be benefited by irrigation. The results expected from this work are very considerable, and it is to be extended as fast as the means at command of the Survey will permit.

It is hardly necessary to say that the work here recorded has been done with the care and thoroughness which have always characterized the methods of the Geological Survey. Of the excellence of its maps we have already spoken, and when the series is completed they will form an atlas of which the United States may well be proud.

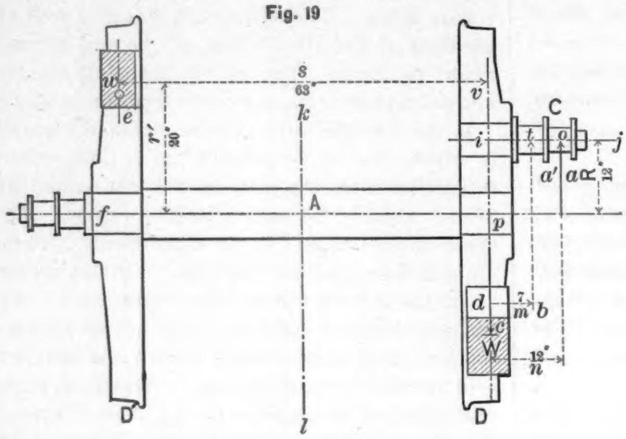
## COUNTERBALANCING THE REVOLVING AND RECIPROCATING PARTS OF LOCOMOTIVES.

(*Concluded from page 100.*)

If the counterweights which are used to balance the revolving and reciprocating parts of locomotives, could be placed axially opposite to the crank-pin, the horizontal disturbing action of these parts could thus be entirely neutralized or balanced. There is a practical difficulty in doing this, because such weights must be put between the spokes of the wheels, and in that position they are not axially opposite to the point where such weights act on the crank-pin, as is shown in fig. 19, in which *C* is the crank-pin and *W* the counterweight. The center of gravity *c* of the latter is 12 in. nearer to the center, line *k l* of the engine than the center of the journal *o* of the crank-pin is, as indicated by the dimension-line *n*. If, now, it is assumed that fig. 19 is a plan—that is, that we are looking down on the wheels and axle, and that the coupling-rod is attached to the outside journal *o* of the crank-pin, its weight would then exert a centrifugal force against the pin in the direction indicated by the dart *a* and the counterweight *W* would exert a force in the opposite direction, as indicated by the dart *d*.

To simplify the illustration, it will be supposed that the center-line *f p* of the axle, the line *i p* drawn through the center of gravity of the counterweight, and the center-line *i j* of the crank-pin are represented by the dark line *f p i j*, fig. 20, and that this line represents a bent lever of the form shown. It is now evident that if there is a force *a* acting against the lever at *o*, and another at *d* acting at *p* in the opposite direction, that the tendency of these two forces will be to turn the lever into a position indicated by the dotted lines *g p i j*; as these two forces are not in equilibrium. If, however, we could apply a third force *e*, which would act at the opposite end *f* of the lever, in the same direction as *a*, and if $e + a = d$ and if *e* and *a* be properly proportioned to each other, then the forces acting on the lever would be in equlibrium, or would balance each other. In the same way the forces *a* and *d* acting on the crank-pin and wheel, as represented in fig. 19, tend to turn the wheels and axle about a vertical axis of least resistance, and they thus cause what is called "nosing" and rolling of the locomotive. For these reasons it is desirable to introduce a force at the opposite end *f* of the axle, which will act in a similar way to *e* in fig. 20. This end can be accomplished by putting a supplementary counterweight *w*, fig. 19, in the wheel *D'* and on the same side of

Fig. 19



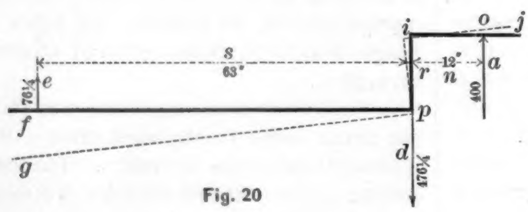




Fig. 20

Fig. 21

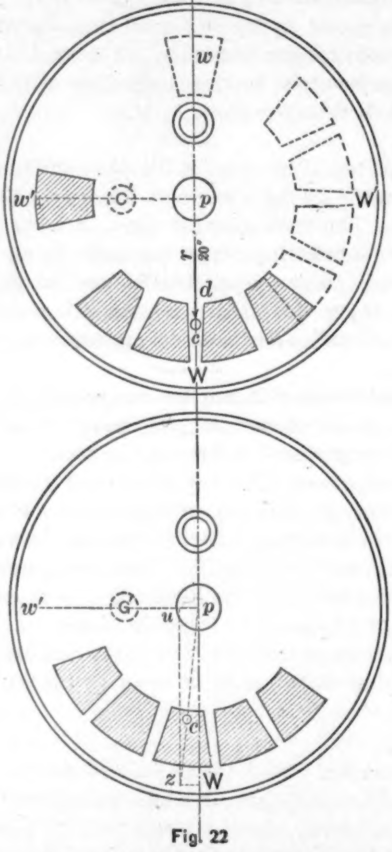



Fig. 22

the axle that the crank-pin *C* is on. The centrifugal force of the supplementary counterweight will act in the direction of the dart *e*. If, now, *w* is so proportioned that the force $a \times n = e \times s$ (*s* being the horizontal distance of the center of gravity of *w* from the center of gravity of *W*), and if *W* be made of such a weight that $d = a + e$, then the wheels will be perfectly balanced.

To calculate the weight of *W* and *w*, we must first know the weight of the coupling-rod or rods attached to the journal *o*, and then calculate the centrifugal force of this weight exerted at *o*. As coupling-rods are connected to two wheels, a counterweight must be provided in each wheel for *one-half* the weight of the coupling-rod or rods attached to each wheel. In the present example it will be assumed that we have a four-wheeled coupled engine and only one coupling-rod on each side, and that the weight of each is 240 lbs., and therefore that we must calculate the

centrifugal force of 120 lbs. exerted at *o*, fig. 19. The rule for calculating the centrifugal force was given in the first article of this series, published in the February number of the JOURNAL.

In making the calculations we may assume any speed, say 60 miles per hour, and that the wheels are 62 in. diameter and the stroke of the pistons 2 ft. The wheels would then revolve 325 times per minute. By the rule given we would then have:

$120 \times 325^2 \times 1 \times .00034 = 4{,}309.5 =$ the centrifugal force exerted at *a*. As the horizontal distance *n* of *a* from the center of gravity of *W* is 12 in. and the distance *s* between the centers of gravity of the weights *W* and *w* is 63 in., we must ascertain the force which must be exerted at *e* and at *W* to balance 4,309.5 lbs. at *a*. As *a* and *e*, by the principle of the lever, are inversely proportional to the length of the lever arms *s* and *n* we will have:

$$\frac{4{,}309.5 \times 12}{63} = 821$$

= the centrifugal force at *e*. To balance *a* and *e* *d* must be equal to *a* + *e* — that is, $4{,}309.5 + 821 = 5{,}130.5 =$ the force *d*, which must be exerted by the counterweight *W*. The problem, then, is to ascertain the weights *w* and *W*, which at a speed of 60 miles per hour will exert centrifugal

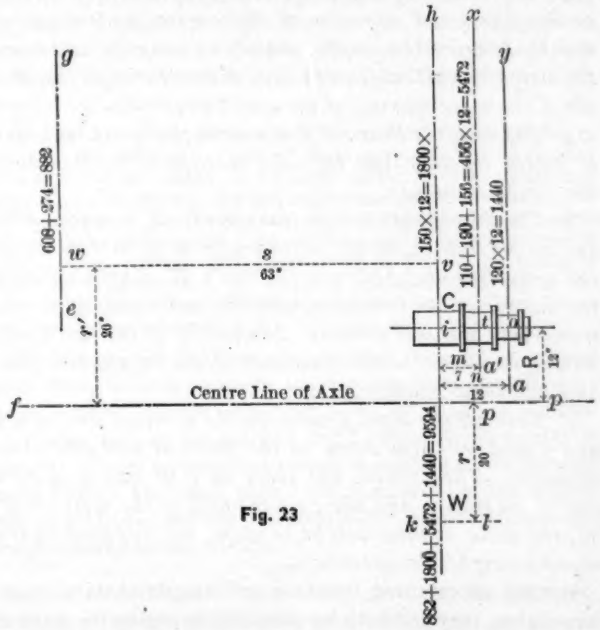



Fig. 23

forces *e* and *d* of 821 and 4,860.5. By expressing the rule for calculating centrifugal force algebraically, the solution will be apparent. Thus, let

$W$ = weight in lbs. of the revolving part.

$N$ = number of revolutions per minute.

$R$ = radius or distance in feet from the center of motion.

.00034 = a constant.

$F$ = centrifugal force.

Thus the formula for centrifugal force becomes:

$$W \times N^2 \times r \times .00034 = F$$

$$\text{and } W = \frac{F}{N^2 \times r \times .00034}.$$

Or, stated arithmetically, to ascertain the weight required to produce a given centrifugal force:

*Multiply the square of the number of revolutions per minute, the radius or distance in feet of the center of gravity of the weight from the center of motion, and .00034 together, and divide the centrifugal force by the product. The quotient will be the required weight.*

Therefore the distance *c p*, of the center of gravity, of the counterweight from the center of the axle being equal to 20 in. and that of *w* the same, we will have:

$$\frac{821}{325^2 \times 1\frac{2}{3} \times .00034} = 13.7 = w,$$

$$\text{and } \frac{5{,}130.5}{325^2 \times 1\frac{2}{3} \times .00034} = 86 = W.$$

It remains to calculate the counterweights required to balance the centrifugal force exerted by the reciprocating parts and main connecting-rod on the journal *t* of the crank-pin. Before making this calculation it must be decided what proportion of the reciprocating parts will be counterbalanced. It will be assumed that, by balancing one-half of them we will get the best results, and that the back end only of the main connecting-rod may be regarded as a revolving weight, and that the weights of the different parts are as follows:

| | Revolving weights. lbs. | Reciprocating weights. lbs. |
|---|---|---|
| Crank-pin boss | 150 | .... |
| Crank-pin | 110 | .... |
| Back end of main connecting-rod | 190 | .... |
| Front end of " " " | .... | 150 |
| Cross-head | .... | 174 |
| Piston and piston-rod | .... | 300 |
| Totals | 450 | 624 |

If we balance one-half the weight of the reciprocating parts and divide that half equally between the two wheels, and omit the crank-pin boss, we will have $300 + 156 = 456$ lbs. as the total weight attached to the journal *t* to be balanced. Observing that the horizontal distance *m*, fig. 19, of the center of gravity of *W* is only 7 in. from the middle of the journal *t*, and calculations similar to the preceding will show that the weights at *w* and *W* to balance 456 lbs. at *t* will be

$$w = 30.4$$
$$W = 304.$$

In addition thereto the crank-pin boss must also be balanced, but as its center of gravity and that of the counterweight *W* are in the same plane, no supplementary counterweight is needed. Its counterweight is calculated by multiplying its own weight by the stroke $R = 12$ in. and dividing by the distance *r* of the center of gravity of *W* from the center of the axle = 20 in. We will therefore have:

$$\frac{150 \times 12}{20} = 90.$$

By adding all these weights together we have:

$$w = 13.7 + 30.4 = 44.1 \text{ lbs.}$$
$$W = 86. + 304 + 90 = 480. \text{ lbs.}$$

In order to get a sufficient amount of counterweight in a wheel it is essential to divide the main counterweight between a number of spokes, as shown by the shaded areas at *W* in fig. 21. The supplementary counterweight in the opposite wheel would be in the position shown by dotted lines at *w*. If the opposite crank-pin is in the position shown by the dotted circle *C'*, then its main counterweights will be in the opposite wheel, in the position indicated by the dotted lines at *W'*, and its supplementary counterweight will be in the nearest wheel, as shown by the shaded area at *w'*. It will be seen that there will

thus be two sets of counterweights in each wheel. Those in the nearest wheel are shown by the shaded areas, and those in the opposite wheel by the dotted lines. The centrifugal forces of the two sets in the nearest wheel act in the direction of the lines *p W* and *p w'*, drawn through the center of the axle and the center of gravity of the counterweights. By the principle of the parallelogram of forces we can resolve the effects of these two separate sets of counterbalances into a common resultant. As the centrifugal force of each will be proportional to its weight, if their centers of gravity are at equal distances from the center of the axle, if to any convenient scale we lay off on *p W*, fig. 22, a distance, *p W*, equal to the counterweights *W*, and on *p w'*, the direction in which the force of *w'*, fig. 21, acts, a distance, *p u*, = to the weight *w'*, then if we construct a parallelogram *u p W z*, with *u p* and *p W* as sides, and draw a diagonal *p z*, it will represent the magnitude and direction of a resultant of the two forces *W* and *w'*. If, then, we arrange a single counterweight, or a group of them, with their common center of gravity *c* on the line *p z*, as shown in fig. 22, they will act the same as the two separate systems *W* and *w*, shown in fig. 21, would. The counterweights may therefore be arranged as shown in fig. 22.

If the main rods took hold of the outside journal of the crank-pin as they do in Mogul, Consolidation, and some other classes of locomotives, obviously the supplementary weight must be heavier, because the combined weight of the back end of the main connecting-rod and the reciprocating parts is greater than that of the coupling-rods, and the supplementary counterweight must be increased the greater the distance, *m* or *n*, fig. 19, that the point of attachment to the crank-pin is from the center of gravity of the main counterweight. On most four-wheeled coupled engines in this country which have a truck, the coupling-rods are connected to the outside journals of the crank-pins.

The ordinary rule which is employed for calculating counterweights, is the following :

RULE I.

*Find the separate revolving weights, in pounds, of crank-pin, crank-pin boss, coupling-rods, and back end of connecting-rod for each wheel ; also the reciprocating weight for the piston and appendages, and the front end of the connecting-rod. Take one-half* of the reciprocating weight and divide it equally between the coupled wheels, and add the part so allotted to the revolving weight on each wheel ; the sums so obtained are the weights to be balanced at the several wheels. Multiply these weights by the length of crank in inches, and divide by the distance in inches of the center of gravity of the space to be occupied by the counterweight from the center of the axle. The result will be the counterweight, in pounds, to be placed diametrically opposite to the crank-pin.*

This rule takes no account of what may be called the transverse disturbing action of the revolving and reciprocating parts, and their counterweight, which is due to their revolution in different planes or at different distances from the center of the engine, which has been explained in this article. Before giving the rule which takes this action into account, it should be remarked that it may be assumed, without material error, that the center of gravity of a crank-pin, like that shown in fig. 19, is on the vertical line *t b* drawn through the middle of the journal *t*, and the center of gravity of the crank-pin boss is on the line *v W* drawn through the center of gravity of the counterweight. The reasoning which has been given regarding the transverse action of the counterweights may then be reduced to the following rule for calculating them :

* From one-half to three-quarters should be taken. No exact rule can be given for this.

RULE II.

1. *Ascertain the weights, in pounds, of the revolving parts on each journal of each crank-pin.*
2. *Then on a drawing of the crank-pin, fig. 23, lay off a line* v W *at right angles to the axis of the pin and passing through the middle, or the center of gravity of the main counterweight. Then draw similar lines* x a' *and* y a *through the middle of the journals* t *and* o, *and lay off* f p *the center-line of the axle, and the horizontal lines* w v *and* k l *drawn through the centers of gravity of the two counterweights* w *and* W. *Also for convenience mark on the drawing the distances* s, m, n, r, *and* r'.
3. *Set down the weights of the revolving parts on the respective lines drawn at right angles to the axis of the crank-pin.**
4. *Take one-half† of the whole weight of the reciprocating parts, on one side of the engine, and divide it equally between the coupled wheels on one side, and mark the weight‡ so allotted on the line drawn through the middle of the main journal of the crank-pin.*
5. *The weights thus set down on each line should then be added together and the sum multiplied by* R = *half the stroke in inches.*
6. *Then multiply each of these products, excepting the one on the line* h i, *by the distance* (m *or* n) *in inches, of the respective weights from the line* v W, *drawn through the middle of the counterweight* W, *and divide by* s*—the transverse distance between the centers of the two counterweights—and set the quotients down on the line* g w, *and add them together.*
7. *Take all the final figures on the vertical lines* g h x *and* y *and set them down on the line* i W *and add them together. Then divide the sums on* i W *and* g w *by* r *and* r', *in inches, and the quotient will be the weights of* W, *the main counterweight, and* w, *the supplementary counterweights, respectively.*

Having ascertained the main and supplementary counterweights, they can both be combined in one by the method already explained. By adding the two together the combined weight in each wheel, by Rule II, would be 524.1 lbs. If we calculate the weight by the first rule it will be found that it gives 435.6 lbs. It will thus be seen that the second rule gives a somewhat heavier counterweight than the first. While this promotes the horizontal stability of the engine, it increases the vertical disturbance. It will be noticed that by Rule II the supplementary counterweight is less than one-tenth that of the main one. If, however, the main connecting-rod was attached to the outside journal *o* of the crank-pin, and if this was increased in length, as it often is on Mogul and Consolidation engines, then the supplementary weight would bear a larger proportion to the main one than in the example selected, and it

* In this case the crank-pin boss = 150 lbs. on vertical line *h*, the crank-pin = 110 lbs., and the back end of main connecting-rod = 190 lbs. on *x*, and one-half the coupling-rod = 120 lbs. on *y*.

† Or any other proportion that may be decided upon.

‡ As given above = 156 lbs.

would then be more important that provision should be made to balance the disturbance which requires this larger weight. As already remarked, Rule II gives heavier counterweights than the first one. They cause more vertical disturbance than lighter weights would, and this disturbance increases very rapidly with the speed. As the main connecting-rods of nearly all passenger locomotives are attached to the inside journals of their crank-pins, the inference might be drawn that Rule I should be used for passenger engines or those whose main connecting-rods are attached to the inside journal, and Rule II is best adapted for freight engines which are connected to the outside journals.

## NEW PUBLICATIONS.

WIE SOLL TARIFIRT WERDEN? EIN BEITRAG ZUR LÖSUNG DER FRAGE DER PERSONENTARIF REFORM. Vienna, Buda-pest and Leipzig; A. Hartleben.

This is not—as a too free rendering of the German title might indicate—a pamphlet on "Tariff Reform," as we understand it in this country; it is a contribution to the great discussion which is now occupying the railroad authorities of Germany and Austria, and naturally the public also, on Passenger Rates and the best method of equalizing and adjusting them. The present book considers the question from several points of view, and especially in relation to the "Zone System," lately adopted on the Austro-Hungarian railroads. Perhaps the intent can best be described by the following extracts from the preface of the anonymous author:

The reform of the present irrational schedules of passenger rates on the railroads is one of those questions a final answer to which can no longer be set aside as out of order, since it is rooted deep in the self-interest of almost every individual.

The Press of all Europe has entered the opening wedge by almost daily discussions; the representatives of the people in almost every country have taken it up as part of the business on their programme; the railroad managements, which acknowledge that these demands come before all others, have employed themselves for some time past with the study.

While the question does not yet—and does not at present seem likely to—engage public interest here as in Europe, there is little doubt that our passenger tariffs are as full of inconsistencies as those of Europe, and that a reform would benefit all parties. Under our system a general movement would be much more difficult here than there; but discussion of the subject will do no harm, and the pamphlet under consideration is well worth reading in this relation.

HANDBOOK OF FREIGHT ACCOUNTS: BY MARSHALL M. KIRKMAN. Chicago; published for the Author.

This latest addition to Mr. Kirkman's series of books on Railroad Accounts treats of the methods of handling freight; the theory and practice of accounts; rules and regulations governing agents, and the returns to be made by them. While the book outlines a particular system of accounts, he expressly disclaims any wish that a single system should be prescribed for all railroads, believing that such a plan would stop development, prevent progress and forbid individual effort and further improvement. All that is to be asked is that results should be stated uniformly, leaving to the discretion of each company the best method of arriving at them.

While this is true, it is also true that there is now altogether too wide a divergence in methods, and that some general understanding—which does not at all imply a general acceptance of a cast-iron system—is very desirable. The present book may be of much service in bringing this about, if properly received and used.

To criticise the book in detail would hardly be in place here; it is enough to say that Mr. Kirkman's authority as a writer—indeed the only writer—on Railroad Accounts is so high that what he says is pretty sure to find a respectful hearing among those to whom he addresses himself. The book contains 157 pages of text, an appendix containing 51 pages of blanks and forms, and a sufficient index. It is published in uniform style with the preceding books of the series, but like its predecessors is entirely independent and can be used without reference to the others.

THE DANGER AND WRONG OF EXISTING LEGISLATION CONCERNING RAILROADS: A REVIEW OF ITS RESULTS. Chicago; the *Railway Age* Publishing Company (price, 25 cents).

This pamphlet is a reprint of the remarks of Mr. T. B. Blackstone, President of the Chicago & Alton Railroad Company, which were appended to the annual report of that company, recently issued. The summary of these remarks published in the papers attracted much attention, and the *Railway Age* has done a service to railroad men and others interested by publishing them in a form which is accessible to every one.

Mr. Blackstone complains bitterly of the general policy adopted by the National Government and the States toward railroad corporations for several years past, and charges that the result of this policy has been to make a large part of the railroad property of the country unprofitable. The remedy suggested is a radical one, being the ownership of all the railroads by the National Government.

Not every one will be willing to admit Mr. Blackstone's premises, and very few will be ready to accept his startling conclusion. His standing and reputation as the manager for many years of a very successful railroad company, however, give his words weight, and, whether we agree with him or not, his argument is a contribution to the literature of the question which deserves reading.

We agree with the publishers in hoping that it will call out a reply from some of those who are competent, from experience and standing, to discuss the subject with authority.

## BOOKS RECEIVED.

SELECTED PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; published by the Institution. The present issue includes the following titles: Compound Locomotives, by Ernest Polonceau; Piers and Harbors on the North and West Coasts of Scotland, by James Barron; Hydraulic Packing Presses, by Charles Hopkinson; the Tacheometer, by Neil Kennedy; Inland Steam Navigation in India, by Alexander Joseph Bolton; Scientific Fortification in China, by William M. McDowdall; Jetties in the United States, by Professor Lewis M. Haupt; Abstracts of Papers in Foreign Transactions and Periodicals.

TRANSACTIONS OF THE LIVERPOOL ENGINEERING SOCIETY, VOLUME IX., SESSION OF 1888, AND VOLUME X., FIFTEENTH SESSION: EDITED BY J. H. T. TURNER, HONORARY SECRETARY. Liverpool, England; published by the Society.

REPORTS OF THE CONSULS OF THE UNITED STATES TO THE DEPARTMENT OF STATE: NOS. 110 AND 111, NOVEMBER AND DECEMBER, 1889. Washington; Government Printing Office. The present volume of Consular Reports relates entirely to the subject of Mortgages in Foreign Countries.

ANNUAL REPORT AND STATEMENTS OF THE CHIEF OF THE BUREAU OF STATISTICS, TREASURY DEPARTMENT, ON THE FOREIGN COMMERCE AND NAVIGATION, IMMIGRATION AND TONNAGE OF THE UNITED STATES, FOR THE FISCAL YEAR ENDING JUNE 30, 1889: S. G. BROCK, CHIEF OF BUREAU. Washington; Government Printing Office.

THIRD ANNUAL REPORT OF THE BOARD OF MEDIATION AND ARBITRATION OF THE STATE OF NEW YORK; FOR THE YEAR 1889: WILLIAM PURCELL, GILBERT ROBERTSON, JR., FLORENCE F. DONOVAN, COMMISSIONERS. Albany, N. Y.; State Printer.

Annual Report of the State Board of Arbitration of Massachusetts for the Year 1889. Charles H. Walcott, Richard P. Barry, Ezra Davol, Members of the Board. Boston, Mass.; State Printers.

Eighteenth Annual Report of the Superintendent of Water Works, Bay City, Mich., for 1889: E. L. Dunbar, Superintendent. Bay City, Mich.; published for the City.

Quarterly Report of the Chief of the Bureau of Statistics, Treasury Department, on Imports, Exports, Immigration and Navigation: for the Quarter ending September 30, 1889. Washington; Government Printing Office.

Seventh Annual Report of the Board of Railroad Commissioners of the State of Kansas, for the Year ending December 1, 1889: Albert R. Greene, James Humphrey, George T. Anthony, Commissioners. Topeka, Kan.; State Printer.

Cornell University, College of Agriculture: Bulletin of the Agricultural Experiment Station. No. XV., December, 1889. Ithaca, N. Y.; published by the University.

Automatic Brakes and Couplers; Progress Made in the Equipment of Freight Cars. Pittsburgh, Pa.; issued by the Westinghouse Air Brake Company. This pamphlet gives a statistical account of the progress made up to the close of 1889 in equipping freight cars in this country with automatic brakes and couplers. It contains a map of the United States, showing the railroads on which the automatic brake has been adopted for freight equipment.

Electrical Accumulators or Storage Batteries: by Pedro G. Salom. Philadelphia; published for the Author. This is a reprint of a paper read before the American Institute of Mining Engineers at the Washington Meeting in February.

An Improved System in the Construction of Railroad Cars: by Max A. Zürcher, Assistant Engineer Canadian Pacific Railway. New York; published for the Author. This pamphlet describes a new system of metallic framing for cars, the invention of Mr. Zürcher, who has had many years' experience on bridge and railroad work.

Silicated Iron and Steel: Circular No. 3. Chicago; issued by the Mullins Silicated Iron & Steel Company.

Buckeye Portland Cement: Manufacture, Tests and Uses. Bellefontaine, O.; issued by the Buckeye Portland Cement Company.

Solid Emery Wheels and Grinding Machines, Knife-Sharpeners, Oil or Whetstones, Diamond Tools and Emery: Catalogue. Stroudsburg, Monroe County, Pa.; issued by the Tanite Company.

## ABOUT BOOKS AND PERIODICALS.

The quarterly Journal of the American Society of Naval Engineers for February has several valuable papers presented at meetings of the Society. These include Speed Trials of Fast Ships, by Assistant Engineers Harold P. Norton and Walter M. McFarland; Marshall Valve Gear, by Passed Assistant Engineer Ira N. Hollis; Test of Worthington Pumping Engines, by Chief Engineer Isherwood; descriptions of the new torpedo-boat *Cushing* and of the second trial of the *Baltimore*, giving the full results then obtained.

It is announced that the Electrical Engineer, the oldest periodical in its department in this country, will be published weekly hereafter, instead of monthly, the change beginning with April. The management of the paper will be in the hands of Messrs. George M. Phelps, T. Commerford Martin and Joseph Wetzer. We wish our electrical contemporary the fullest success, and do not doubt that it will continue to keep the high reputation it has always held and deserved in its field.

The Gross and Net Gain of Rising Wages is a very thoughtful and well-considered article in the Popular Science Monthly for March. The Editor's Table and the correspondence contain, as usual, some bright and interesting discussions.

Mr. Leo Von Rosenberg, New York, has now in press the Washington Bridge, a monograph by Mr. William R. Hutton, Chief Engineer. This bridge, which crosses the Harlem River Valley at 181st Street, New York, is a notable example of bridge construction and well worth careful study by engineers. The book will contain a full description, with 24 large engravings, made from photographs taken during and after construction, and a large number of plates showing very fully the details of the masonry and superstructure. It will be printed in the very best manner, and will make a very handsome volume.

The second article on John Ericsson in the March number of Scribner's Magazine is devoted to his great inventions. Among the engravings are views of the *Novelty* locomotive and of the first steam fire-engine, and fac-similes of the original pencil sketches for the *Monitor*, made in 1854.

The article on Creedmoor and the National Guard, by Lieutenant W. R. Hamilton, in Outing for March, is an account of what has been done in New York in the very important matter of improving the marksmanship of the State troops. The number generally has a breezy, out-of-doors flavor about it which reminds us that Winter is over and the season for open-air sports is near.

In Harper's Magazine for March, the venerable "Easy Chair" speaks of some aspects of city engineering as seen in New York streets. The army series is continued by General Merritt's very interesting article on the Army of the United States, which is chiefly historical and descriptive.

The new Boston magazine, the Arena, seems determined to open a field peculiarly its own—the free discussion of questions of public interest on all sides, giving the greatest latitude to the expression of opinion. In the March number, as in the preceding ones, the writers are all people of mark, and, whether the reader agrees with them or not, he must admit that they all have something to say and present their arguments ably, if not convincingly.

Many engineers will be interested in Major J. W. Powell's article on the Irrigable Lands of the Arid Region in the March Century. Engineers, and a good many others also, should see Mr. Shaw's article on Glasgow—a Municipal Study. This account of the methods adopted in the great Scotch city deserves a careful reading.

Among the articles in the School of Mines Quarterly for January are Public Street Lighting in New York, by E. G. Love; Patent Equivalents, by Emil Starek; Irrigation Engineering, by H. M. Wilson, and several others of special interest.

The London Industries has issued a voluminous special number giving an account of the Forth Bridge, both historical and descriptive. It is profusely illustrated, the engravings showing the bridge as completed, the work in various stages of progress and many details of construction. This special number is worth preservation, as it gives in connected form an account of the great bridge, and many facts which would otherwise have to be hunted up through many papers.

The London Engineering also issues a special Forth Bridge number, in connection with the opening of the bridge. This is illustrated, most of the engravings having been published heretofore in the columns of the paper; but they are now brought together under one cover, in such a way as to make them convenient for keeping and reference.

## GRÜSON'S QUICK-FIRE GUNS.

(From the London *Engineer*.)

We have received a very complete report in English of Herr Grüson's new quick-fire guns. This has a special interest, inasmuch as he has developed an entire system of guns, carriages and shields. It appears that Grüson, at an early stage of his inquiry, concluded that five classes of quick-fire guns were necessary in addition to machine guns. Many of these quick-fire guns have been supplied to governments, and have borne severe tests for endurance; guns from which 2,000 rounds have been fired have shown a complete absence of any trace of erosion. It is laid down that the crucible steel used in the pieces must bear a strain of 35.3 tons per square inch, with 15 per cent. extension and an elastic limit of 16.5 tons per square inch. The standard thus indicated has, however, in all cases been greatly exceeded. The five guns in question are as follows: 1. The 3.7 cm. (1.46 in.) gun, 23 calibers long; 2. The 5.3 cm. (2.09 in.) gun, 24 calibers long; 3. The 5.3 cm. (2.09 in.) gun, 30 calibers long; 4. The 5.3 cm. (2.09 in.) gun, 39 calibers long; 5. The 5.7 cm. (2.24 in.) gun, 25 calibers long.

The breech mechanism is common to all; it has been found to work with ease and rapidity, a rate of from 35 to 40 rounds per minute having been realized. The cocking of the striker is effected by the downward movement of the breech-block. They are of all kinds only 19 pieces in the mechanism, which is shown herewith in figs. 1, 2 and 3. The general character of the action can be seen in these cuts without going into minute detail. The block *B* is hollowed out at the top, as shown in fig. 3, for the passage of the ammunition. It slides up and down in its vertical slot when the hand-lever *A* is worked. Its downward movement is limited by a screw *C*, working in a vertical groove *y*. The striker *b* is actuated by a spiral spring *c*, and is moved by levers *d d*, on the shaft *d*. The trigger-pin *e* is acted on by the flat spring *t*. It may be fired by a lanyard, which draws back the trigger and releases the striker, or by special levers fitted on.

The piece is worked by two men. One lays, loads and fires, and one hands the ammunition. The gun is in each case made in two parts of forged crucible steel, the barrel and the breech-piece, which is screwed on to it, forming

Fig. 1.

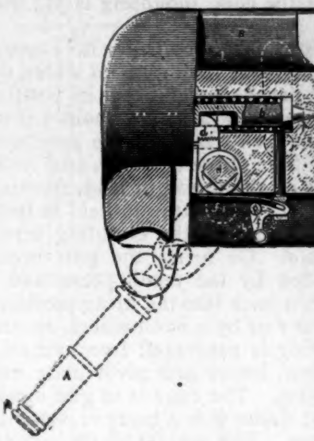


Fig. 2.

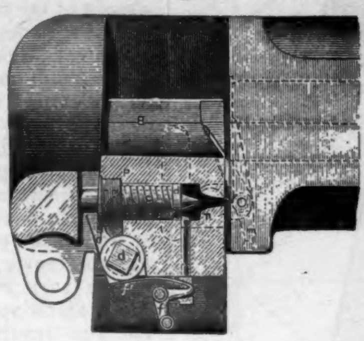
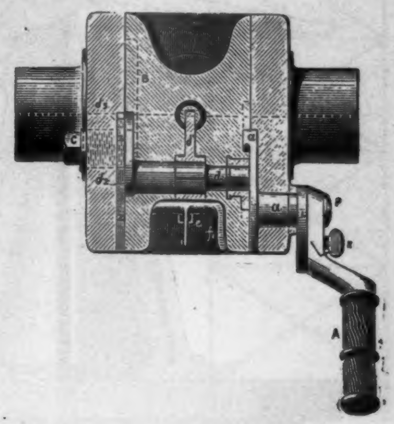
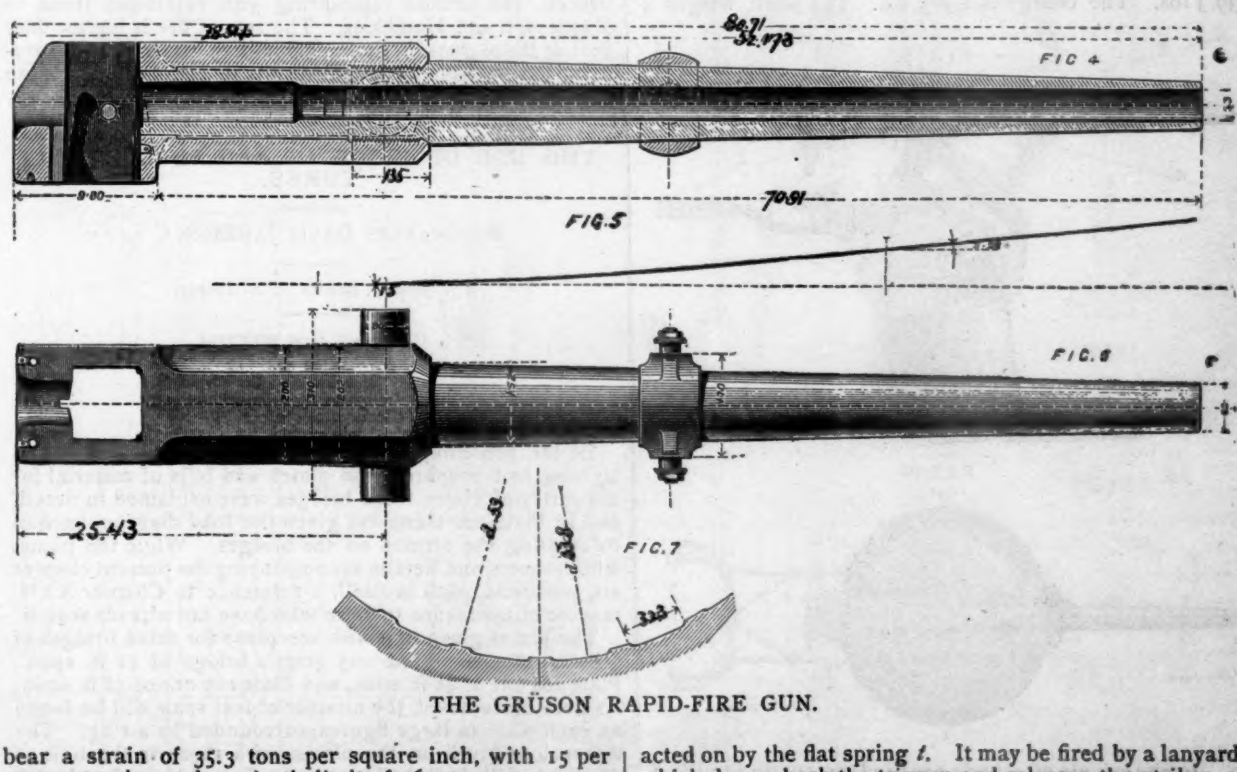


Fig. 3.






THE GRÜSON RAPID-FIRE GUN.

a jacket. Figs. 4, 5, 6 and 7 show the longest 5.3-cm. piece, the fourth gun of those we have enumerated, which appears to be the best to take as an example. The 5.7-cm. gun is a comparatively short piece. The total length of

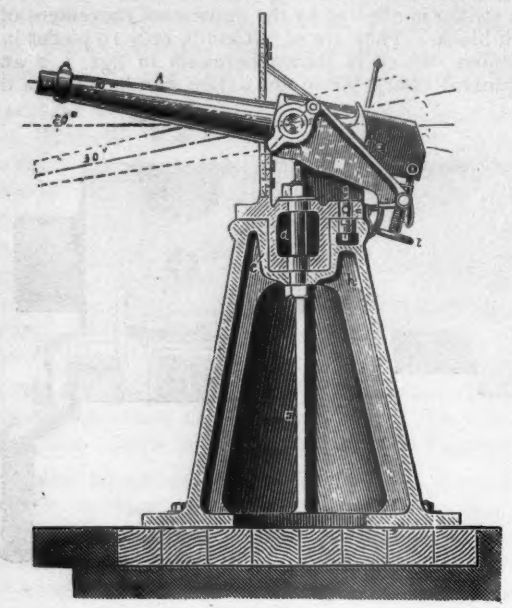


Fig. 8.

the barrel of this 5.3-cm. gun is 73.03 in. The rifling consists of 24 grooves of the section shown in fig. 7. The twist is right-handed, increasing from 1 in 165 to 1 in 30 calibers. The entire gun is 80.7 in. long. The diameter of the powder chamber is 2.52 in., that of the bore being 2.087 in. The gun weighs 595.2 lbs., or with breech-block 639.3 lbs. The charge is 1.565 lbs. The shell weighs 4

FIG 9.

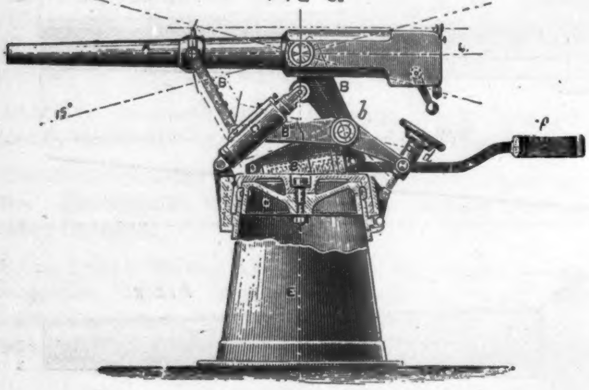
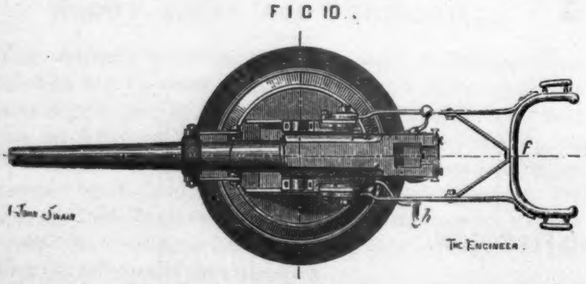


FIG 10.




lbs. In one minute 26 rounds are fired, amounting to 104.3 lbs. The muzzle velocity is 1,969 ft. per second, and the energy of fire per minute 2,804 foot tons. The maximum pressure in the bore is 12.7 tons per square inch.

This gun is intended for naval service. It is mounted on non-recoil cone mounting, similar to that for the 5.3-cm. gun of 24 calibers length, which is shown in fig. 8. Here the gun *A* is on a carriage *B*, with a cast-steel pivot turning on a socket *e* cast in one piece with the cone. The carriage is screwed down by a bolt to prevent its jumping from its socket. Training is effected by a hand-wheel at the further side of the carriage, with box *g* and pin. A pointer is screwed on to the carriage for indirect fire, which indicates the training on a graduated training plate. Elevation is given by a hand-wheel *i* by a double-adjusting screw. The degrees of elevation are read off on the carriage, which is constructed to give 15° elevation and 10° depression. A shield is screwed on to the carriage. The weight of the upper part of the cone mounting is 353 lbs., and of the stand, 794 lbs.

A pivot carriage with an ordinary recoil slide is in course of construction. There is a pivot mounting in which the gun is carried on a jointed parallelogram kept in position by a hydraulic press, its base being movable about a pivot or cone. In fig. 9, *A* is the gun; $B\ B^1\ B^2$ the carriage; *C* is the pivot plate; *D* the base of the carriage, and *E* the cone. There are trunnions on the foresight ring, forming part of the jointed system. The structure is held in front by the recoil press *c*, and in rear by the elevating screw and nut moving in the box *d*. On firing, the gun recoils on the bars $B\ B^1$, controlled by the recoil press, and a strong spiral spring *e* forces it back into the firing position. The gun traverses by a lever *f* or by a hand-wheel on the pivot plate *C*. The mounting is prevented from jumping by a spring bolt. The arms, levers and pivot plate and the moving parts are cast steel. The cone is of gun-metal and the stand of plate iron; under it is a layer of wood to break the shock of discharge. The weight of the mounting is, upper part, 782.6 lbs.; lower part, 771.6 lbs. It has 15° arc of elevation and 15° of depression, and trains through the complete circle. It is worked by two men; one lays and fires, and one loads and acts as a substitute.

The ammunition is in the usual solid-drawn case; the 39-caliber gun fires common and steel armor-piercing shell, but not shrapnel and case. There is no special feature that makes it appear necessary to give a drawing of this ammunition. In the general system of working the breech, the Grüson rapid-firing gun resembles those of Nordenfelt and Hotchkiss. The rate of fire is higher than that of those guns in their competitive trials at Shoeburyness, but we have no recent results to compare with those of Herr Grüson.

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## THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C.E.



(*Continued from page* 133.)

### CHAPTER XXIII.

### HOWE TRUSS BRIDGES.

In the preceding chapter the methods followed in designing and preparing the plates and bills of material for the series of Howe truss bridges were explained in detail, and in Plate 100 there was given the load diagram used in calculating the strains on the bridges. While the plans, strain-sheets and details accompanying the present chapter are complete, each in itself, a reference to Chapter XXII. may be of assistance to those who have not already seen it.

The plates given herewith are plans for three bridges of different spans. Plate 103 gives a bridge of 42 ft. span; Plate 104 one of 48 ft. span, and Plate 105 one of 52 ft. span. As heretofore noted, the number of feet span will be found on each plate in large figures, surrounded by a ring. The dimensions given on the plates, with those in the bills of material, will, it is believed, be sufficient to make of each a working plan which can be used without further preparation.

The accompanying bills of material will explain themselves; they have been carefully prepared, and all dimensions are given upon them. The patterns for castings and washers are indicated by letters, and the corresponding

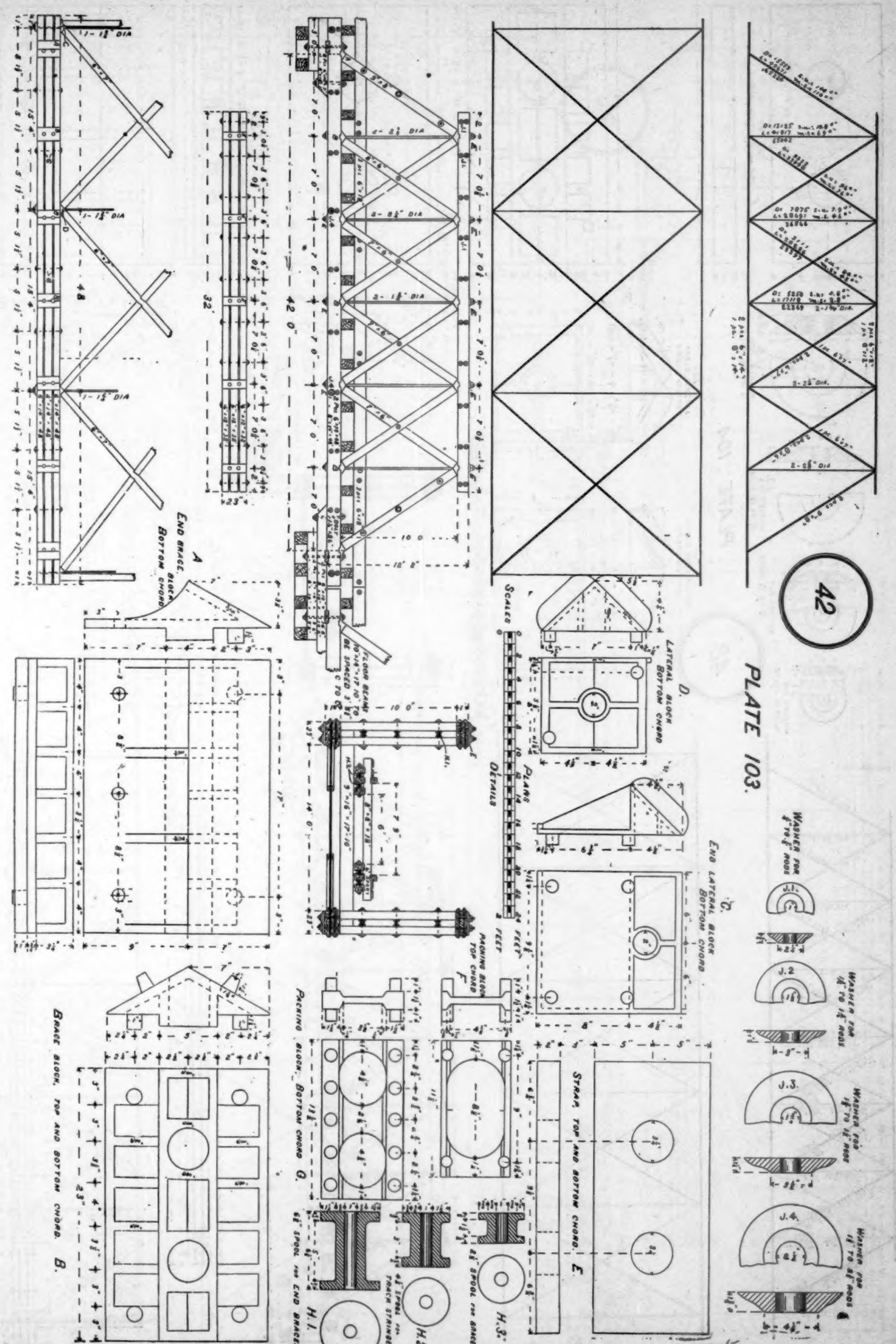


PLATE 103.
42
End brace block bottom chord A
Brace block, top and bottom chord. B.
End lateral block bottom chord C.
Lateral block bottom chord D.
Strap, top and bottom chord E.
Packing block top chord F
Packing block, bottom chord G.
Scales
Plans
Details
Feet
J.1.
J.2
J.3.
J.4.
H.1.
H.2.
H.3.

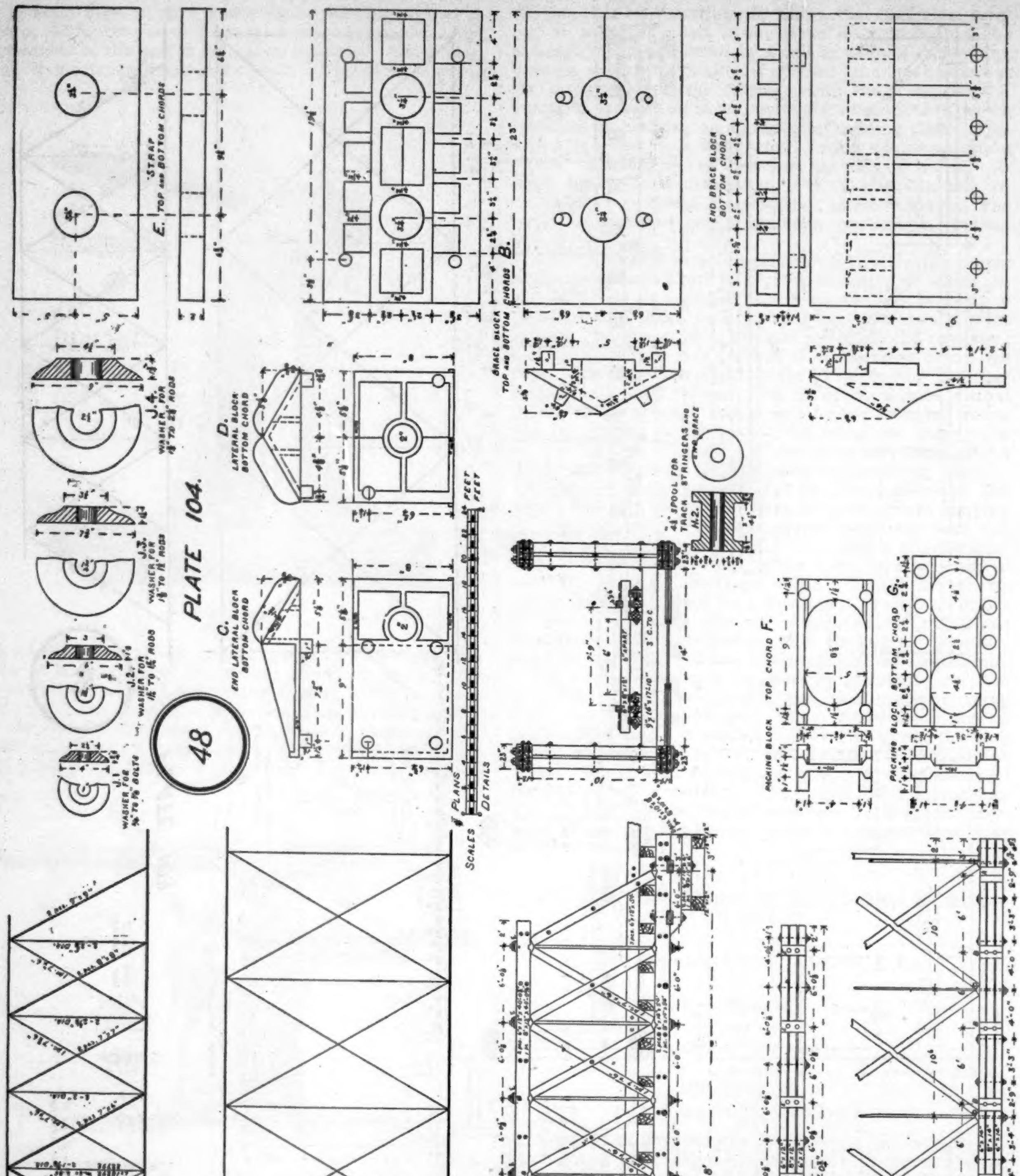


PLATE 104.
48
E. STRAP TOP AND BOTTOM CHORDS
B. BRACE BLOCK TOP AND BOTTOM CHORDS
A. END BRACE BLOCK BOTTOM CHORD
D. LATERAL BLOCK BOTTOM CHORD
C. END LATERAL BLOCK BOTTOM CHORD
N.2. SPOOL FOR TRACK STRINGERS AND LATERAL BRACE
PACKING BLOCK TOP CHORD F.
PACKING BLOCK BOTTOM CHORD G.
SCALES
PLANS
DETAILS
FEET

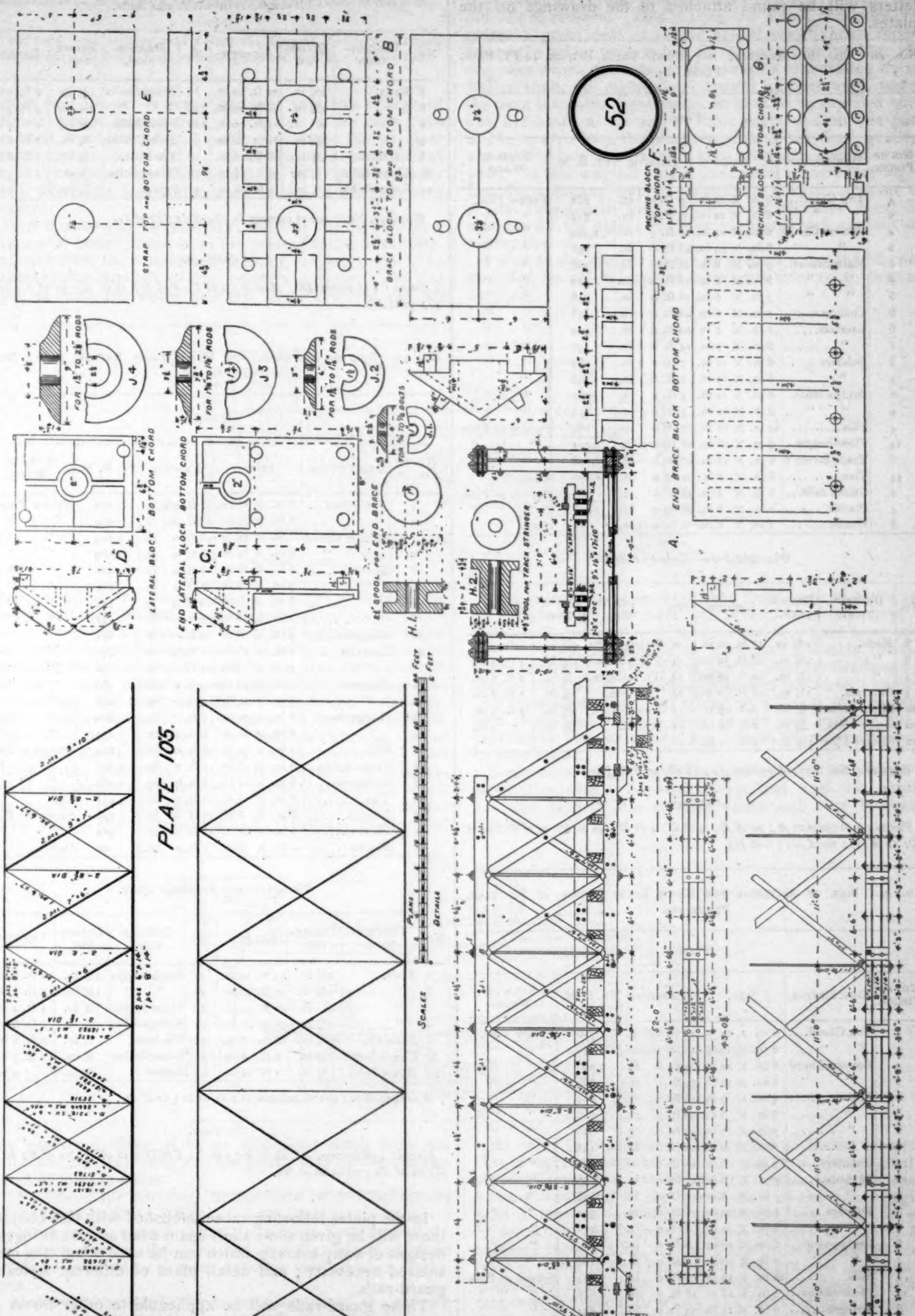


PLATE 105.
52
SCALES

letters will be found attached to the drawings on the plates.

No. 41. BILL OF MATERIAL FOR HOWE TRUSS BRIDGE, 42 FT. SPAN. PLATE 103.

*Wood.*

| No. of Pieces. | Description. | Size. | Length. | Ft. B. M. | Kind of Wood. |
|---|---|---|---|---|---|
| 4 | Top Chord... | 6 in. × 12 in. | 32 ft. 0 in. | 762 | Yellow Pine. |
| 2 | " " ... | 8 in. × 12 in. | 32 ft. 0 in. | 512 | " " |
| 4 | Bottom Chord | 6 in. × 14 in. | 48 ft. 0 in. | 1,344 | " " |
| 2 | " " | 8 in. × 14 in. | 48 ft. 0 in. | 896 | " " |
| 8 | Main Braces.. | 9 in. × 8 in. | 16 ft. 0 in. | 768 | " " |
| 8 | " " | 8 in. × 6 in. | 16 ft. 0 in. | 512 | " " |
| 8 | " " | 7 in. × 6 in. | 16 ft. 0 in. | 448 | " " |
| 8 | Counters... . | 7 in. × 6 in. | 16 ft. 0 in. | 448 | " " |
| 6 | Laterals...... | 6 in. × 7 in. | 20 ft. 0 in. | 420 | " " |
| 2 | " ...... | 6 in. × 7 in. | 14 ft. 0 in. | 98 | " " |
| 8 | Bolsters...... | 6 in. × 10 in. | 7 ft. 0 in. | 280 | " " |
| 4 | " ...... | 8 in. × 10 in. | 7 ft. 0 in. | 190 | " " |
| 8 | Bridge-seats.. | 6 in. × 10 in. | 5 ft. 0 in. | 200 | " " |
| 4 | " " .. | 8 in. × 10 in. | 5 ft. 0 in. | 134 | " " |
| 4 | Sills.......... | 12 in. × 12 in. | 18 ft. 0 in. | 864 | Spruce or Pine |
| 14 | Floor-beams.. | 9 in. × 16 in. | 18 ft. 0 in. | 3,024 | " " " |
| 6 | Track String's | 6 in. × 12 in. | 48 ft. 0 in. | 1,728 | " " " |
| 44 | Ties.......... | 8 in. × 8 in. | 12 ft. 0 in. | 2,816 | Oak. |
| 2 | Guard-rails... | 6 in. × 6 in. | 48 ft. 0 in. | 288 | Spruce or Pine |
| 4 | Planks....... | 2 in. × 8 in. | 48 ft. 0 in. | 256 | " " " |
| 8 | Blocks.... ... | 2 in. × 8 in. | 2 ft. 0 in. | 22 | Oak. |

*Wrought-Iron—Rods and Bolts.*

| No. | Description. | Diameter. | Length. | No. | Description. | Diameter. | Length. |
|---|---|---|---|---|---|---|---|
| 8 | Rods. | 2⅝ in. | 12 ft. 10 in. | 12 | Bolster-b'lts | 1¼ in. | 3 ft. 3 in. |
| 8 | " | 2¼ in. | 12 ft. 10 in. | 14 | Floor-bolts. | 1¼ in. | 4 ft. 4 in. |
| 4 | " | 1¾ in. | 12 ft. 10 in. | 14 | Tr. stringer. | ¾ in. | 2 ft. 6 in. |
| 4 | Laterals. | 1¾ in. | 18 ft. 6 in. | 24 | Tie-bolts. | ¾ in. | 2 ft. 6 in. |
| 72 | Chord-bolts. | ¾ in. | 2 ft. 0½ in. | 14 | Guard-b'lts. | ¾ in. | 1 ft. 3 in. |
| 20 | Brace-bolts. | ¾ in. | 2 ft. 0½ in. | 24 | Spikes. | ⅝ in. | 9 in. |
| 12 | Bolster-b'lts | 1¼ in. | 2 ft. 2 in. | | | | |

*Washers*, No. : 300 of pattern *J1* ; 76 of *J2* ; 8 of *J4*.

*Castings.*

Pieces : 4 of pattern *A* ; 20 of *B* ; 4 of *C* ; 4 of *D* ; 40 of *F* ; 40 of *G* ; 20 of *E* ; 12 of *H1* ; 20 of *H2* ; 8 of *H3*.

No. 42. BILL OF MATERIAL FOR HOWE TRUSS BRIDGE, 48 FT. SPAN. PLATE 104.

*Wood.*

| No. of Pieces. | Description. | Size. | Length. | Ft. B. M. | Kind of Wood. |
|---|---|---|---|---|---|
| 4 | Top Chord.... | 6 in. × 12 in. | 40 ft. 0¾ in. | 760 | Yellow Pine. |
| 2 | " " .... | 8 in. × 12 in. | 40 ft. 0¾ in. | 640 | " " |
| 4 | Bottom Chord | 6 in. × 12 in. | 54 ft. 0 in. | 1,296 | " " |
| 2 | " " | 8 in. × 12 in. | 54 ft. 0 in. | 864 | " " |
| 8 | Braces ... ... | 9 in. × 9 in. | 16 ft. 0 in. | 864 | " " |
| 8 | " ....... | 8 in. × 8 in. | 16 ft. 0 in. | 688 | " " |
| 8 | " ........ | 7 in. × 7 in. | 16 ft. 0 in. | 528 | " " |
| 8 | " ........ | 7 in. × 6 in. | 16 ft. 0 in. | 448 | " " |
| 12 | Counters..... | 7 in. × 6 in. | 16 ft. 0 in. | 672 | " " |
| 10 | Laterals...... | 7 in. × 6 in. | 17 ft. 0 in. | 600 | " " |
| 2 | " ... .. | 7 in. × 6 in. | 14 ft. 0 in. | 98 | " " |
| 8 | Bolsters...... | 6 in. × 10 in. | 8 ft. 0 in. | 320 | " " |
| 4 | " ....... | 8 in. × 10 in. | 8 ft. 0 in. | 216 | " " |
| 8 | Bridge-seats.. | 6 in. × 10 in. | 6 ft. 0 in. | 240 | " " |
| 4 | " " .. | 8 in. × 10 in. | 6 ft. 0 in. | 160 | " " |
| 4 | Sills.......... | 12 in. × 12 in. | 18 ft. 0 in. | 864 | Spruce or Pine |
| 18 | Floor-beams.. | 9 in. × 16 in. | 18 ft. 0 in. | 3,888 | " " " |
| 6 | Stringers...... | 6 in. × 12 in. | 54 ft. 0 in. | 1,944 | " " " |
| 48 | Ties.......... | 8 in. × 8 in. | 12 ft. 0 in. | 3,072 | Oak. |
| 2 | Guards....... | 6 in. × 6 in. | 54 ft. 0 in. | 324 | Spruce or Pine |
| 4 | Planks........ | 2 in. × 8 in. | 54 ft. 0 in. | 288 | " " " |
| 8 | Blocks........ | 2 in. × 8 in. | 2 ft. 0 in. | 24 | Oak. |

*Wrought-Iron—Rods and Bolts.*

| No. | Description. | Diameter. | Length. | No. | Description. | Diameter. | Length. |
|---|---|---|---|---|---|---|---|
| 8 | Rods. | 2⅝ in. | 12 ft. 10 in. | 12 | Bolster bolts | 1¼ in. | 2 ft. 2 in. |
| 8 | " | 2⅜ in. | 12 ft. 10 in. | 12 | " " | 1¼ in. | 3 ft. 3 in. |
| 8 | " | 2 in. | 12 ft. 10 in. | 18 | Floor-bolts. | 1¼ in. | 4 ft. 4 in. |
| 4 | " | 1⅝ in. | 12 ft. 10 in. | 32 | String'rb'lts | ¾ in. | 2 ft. 6 in. |
| 6 | Laterals. | 1¾ in. | 18 ft. 6 in. | 18 | Tie-bolts. | ¾ in. | 2 ft. 6 in. |
| 88 | Chord-bolts. | ¾ in. | 2 ft. 0½ in. | 18 | Guard-bolts. | ¾ in. | 1 ft. 3 in. |
| 24 | Brace-bolts. | ¾ in. | 2 ft. 0½ in. | 32 | Spikes. | ⅝ in. | 9 in. |

*Washers*, No. : 400 of pattern *J1* ; 84 of *J2* ; 12 of *J4*.

*Castings.*

Pieces : 4 of pattern *A* ; 28 of *B* ; 4 of *C* ; 8 of *D* ; 28 of *E* ; 32 of *F* ; 72 of *G* ; 32 of *H2*.

No. 43. BILL OF MATERIAL FOR HOWE TRUSS BRIDGE, 52 FT. SPAN. PLATE 105.

*Wood.*

| No. of Pieces. | Description. | Size. | Length. | Ft. B. M. | Kind of Wood. |
|---|---|---|---|---|---|
| 4 | Top Chord.... | 6 in. × 12 in. | 43 ft. 0¾ in. | 1,056 | Yellow Pine. |
| 2 | " " .... | 8 in. × 12 in. | 43 ft. 0¾ in. | 704 | " " |
| 4 | Bottom Chord | 6 in. × 14 in. | 58 ft. 0 in. | 1,624 | " " |
| 2 | " " | 8 in. × 14 in. | 58 ft. 0 in. | 1,083 | " " |
| 8 | Braces........ | 9 in. × 10 in. | 16 ft. 0 in. | 960 | " " |
| 8 | " ........ | 9 in. × 7 in. | 16 ft. 0 in. | 672 | " " |
| 8 | " ........ | 8 in. × 7 in. | 16 ft. 0 in. | 608 | " " |
| 8 | " ........ | 7 in. × 6 in. | 16 ft. 0 in. | 448 | " " |
| 12 | Counters..... | 7 in. × 6 in. | 16 ft. 0 in. | 672 | " " |
| 10 | Laterals. .... | 7 in. × 6 in. | 18 ft. 0 in. | 630 | " " |
| 2 | " ...... | 7 in. × 6 in. | 14 ft. 0 in. | 98 | " " |
| 8 | Bolsters...... | 6 in. × 10 in. | 9 ft. 0 in. | 360 | " " |
| 4 | " ...... | 8 in. × 10 in. | 9 ft. 0 in. | 240 | " " |
| 8 | Bridge-seats.. | 6 in. × 10 in. | 5 ft. 0 in. | 200 | " " |
| 4 | " " | 8 in. × 10 in. | 5 ft. 0 in. | 134 | " " |
| 4 | Sills.......... | 12 in. × 12 in. | 18 ft. 0 in. | 864 | Spruce or Pine |
| 18 | Floor-beams.. | 9 in. × 16 in. | 18 ft. 0 in. | 3,888 | " " " |
| 6 | Stringers..... | 6 in. × 12 in. | 58 ft. 0 in. | 2,088 | " " " |
| 51 | Ties.......... | 8 in. × 8 in. | 12 ft. 0 in. | 3,264 | Oak. |
| 2 | Guards . .... | 6 in. × 6 in. | 58 ft. 0 in. | 348 | Spruce or Pine |
| 4 | Planks........ | 2 in. × 8 in. | 58 ft. 0 in. | 312 | " " " |
| 8 | Blocks........ | 2 in. × 8 in. | 2 ft. 0 in. | 22 | Oak. |

*Wrought-Iron—Rods and Bolts.*

| No. | Description. | Diameter. | Length. | No. | Description. | Diameter. | Length. |
|---|---|---|---|---|---|---|---|
| 8 | Rods. | 2¾ in. | 12 ft. 10 in. | 12 | Bolster bolts | 1¼ in. | 2 ft. 6 in. |
| 8 | " | 2⅜ in. | 12 ft. 10 in. | 12 | " " | 1¼ in. | 3 ft. 3 in. |
| 8 | " | 2 in. | 12 ft. 10 in. | 18 | Floor-bolts. | 1¼ in. | 4 ft. 4 in. |
| 4 | " | 1¾ in. | 12 ft. 10 in. | 32 | Stringerb'lts | ¾ in. | 2 ft. 6 in. |
| 6 | Laterals. | 1¾ in. | 18 ft. 6 in. | 18 | Tie-bolts. | ¾ in. | 2 ft. 6 in. |
| 84 | Chord-bolts. | ¾ in. | 2 ft. 0½ in. | 18 | Guard-bolts. | ¾ in. | 1 ft. 3 in. |
| 24 | Brace-bolts. | ¾ in. | 2 ft. 0½ in. | 32 | Spikes. | ⅝ in. | 9 in. |

*Washers*, No.: 400 of pattern *I1* ; 84 of *I2* ; 12 of *I4*.

*Castings.*

Pieces : 4 of pattern *A* ; 28 of *B* ; 4 of *C* ; 8 of *D* ; 28 of *E* ; 32 of *F* ; 64 of *G* ; 12 of *H1* ; 20 or 40 of *H2*.

In the plates following those published with this chapter there will be given some short spans used as deck bridges ; designs of sway-bracing which can be used when it is considered necessary ; and detail plans of different styles of guard-rails.

These guard-rails will be applicable to other forms of bridge than those given here ; and there can be no doubt that some device of this kind ought to be used on the approaches of all bridges, without any exception.

(TO BE CONTINUED.)

## BOILERS WITH CORRUGATED FIRE-BOXES.

(Condensed from a paper read before the German Technical Railroad Union, by Herr H. Lentz Engineer, and published in *Glaser's Annalen*.)

It is well known to every engineer who has charge of railroad motive power, that the repairs of the boiler are the most troublesome and costly and cause the greatest loss of time to locomotives. It may be said, indeed, that the boiler repairs overbalance all the other repairs, especially when the feed-water used is not of the very best quality.

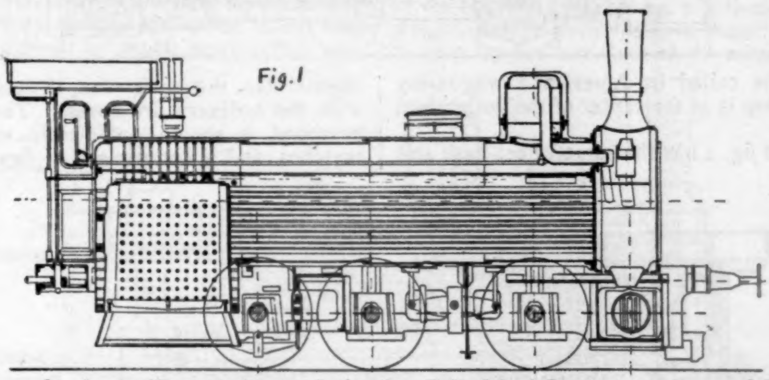
Now it may also be said that most of the trouble in a locomotive boiler arises from the present shape of the fire-box, and from the extensive system of staying required in a rectangular fire-box of the ordinary pattern. The flat sides of both the outer and the inner fire-box and the crown-sheet of the inner fire-box will not withstand the steam pressure without a great number of stays, which not only require a great deal of work in building the boiler and constant watchfulness while it is in service, but also diminish the room, interfere with the free circulation of the water, and afford places upon which sediment can accumulate. In most European locomotives, moreover, where copper is used for fire-boxes, a further difficulty arises from the difference in the coefficient of expansion of the copper plates of the inner fire-box and the iron or steel plates of the outer shell. The strain caused by this unequal expansion is transmitted through stay-bolts which are necessarily very short, and are hence subject to unequal strains and frequently break. It is well known that the greater number of boiler explosions result from the failure of the stay-bolts and the giving way of the flat surfaces of the fire-boxes.

If we take, for instance, the standard freight locomotive of the Prussian State Railroads, a sectional sketch of which is shown in fig. 1, we find that there are in and around the fire-boxes over 800 stay-bolts and braces, the use of which could be avoided by a more rational method of construction.

Moreover, as noted above, on account of the narrow water space between the inside and outside fire-box, and on acccount of the rapid generation of steam and agitation of the water which go on in that place, there is a constant deposit of sediment at the many resting points offered for it by these stays, and the resulting incrustations are very difficult to remove. This part of the boiler, therefore, requires a great deal of repair and of very difficult repair where the water used is not of the very best quality. In one case which came under the writer's observation on an Italian road, the eight-wheel freight engines used, under the most favorable circumstances, have to be supplied with new fire-boxes at the end of three years, and on one part of the road, where the water used is of very bad quality, a new fire-box, braces and stay-bolts are needed every year. In this way not only is the cost of repairs very high, but the company has necessarily a greater amount of capital invested in locomotives, since provision must be made to fill the places of those engines which are laid up for repairs.

I wish in the present paper to present a method of construction by which many of these evils referred to may be avoided.

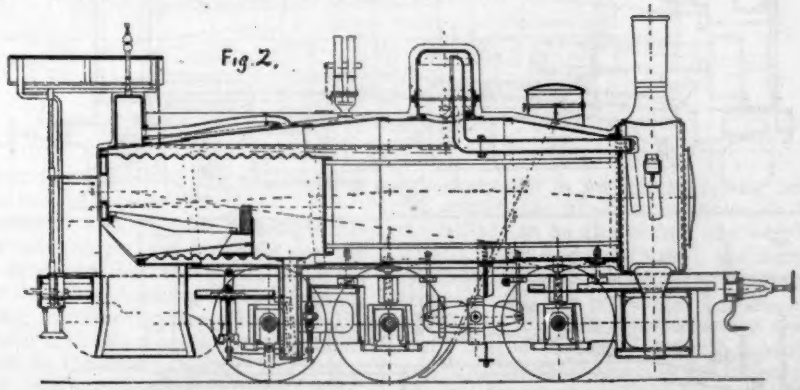
Fig. 1



Cylindrical fire-boxes were used from 15 to 20 years ago by Kaselowsky, and there are several later instances of their use in locomotives. In America they have been used in the Strong locomotive, in that case a double fire-box being provided. The use of the cylindrical fire-boxes in marine boilers and in stationary boilers is also well known. The resistance of the corrugated cylindrical tube to pressure is so high that in those of the size required for a locomotive fire-box almost any attainable pressure would be admissible.

Some time ago Herr Pohlmeyer built in Dortmund* a locomotive with a fire-box of this kind, and this engine has now been in use for two years with very favorable results.

Fig. 2.



In order to make clear this method of boiler construction, I have shown herewith in fig. 1 a section of the standard freight locomotive of the Prussian State Railroads as now built, and in fig. 2 a section of the same engine with a fire-box consisting of a corrugated tube. It will be seen that not only is there an absence of all the flat surfaces shown in fig. 1, and of the great number of stay-bolts required in that engine, but the greatest steam room is provided in the center of the boiler. The smallest diameter is at the rear end, which has the advantage of giving more room in the cab, and while the boiler is higher in the center, it does not reach such a height as to interfere

* This engine, built by Herr Pohlmeyer, was described and illustrated in the Railroad and Engineering Journal for June, 1889, page 272.

with the outlook of the engineer. The section of the boiler at the center is oval and not circular, but this form, it is believed, will present as great a resistance to pressure as the entirely circular boiler. In other words, the boiler is

pattern a very much better arrangement of the axles, giving a longer wheel-base, since the rear axle can be carried as far back under the fire-box as may be desired to proportion the engine properly. With an outside-cylinder

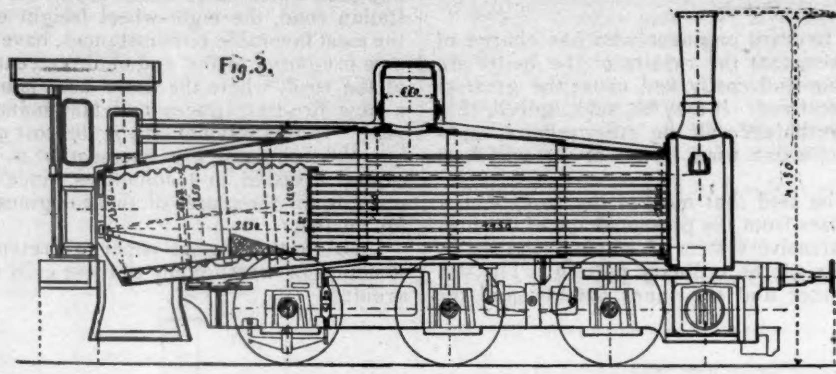


Fig. 3.

somewhat like what is called in America a wagon-top form, but the wagon-top is at the center of the boiler, and not at the rear end.

The engine shown in fig. 2 has the same wheel-base and

engine also, the boiler can, if desired, be set lower than with the ordinary fire-boxes. The general arrangement proposed is shown sufficiently well in these sectional sketches, and a comparison of figs. 1, 2 and 3 will show

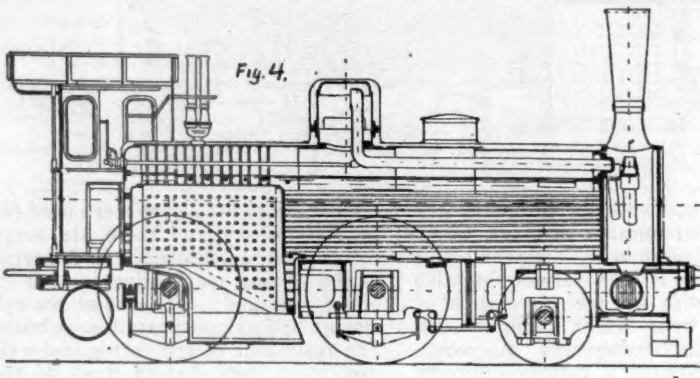


Fig. 4.

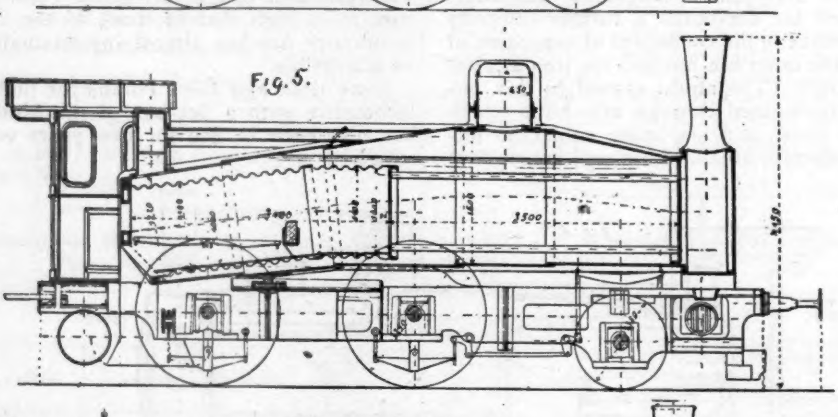


Fig. 5.

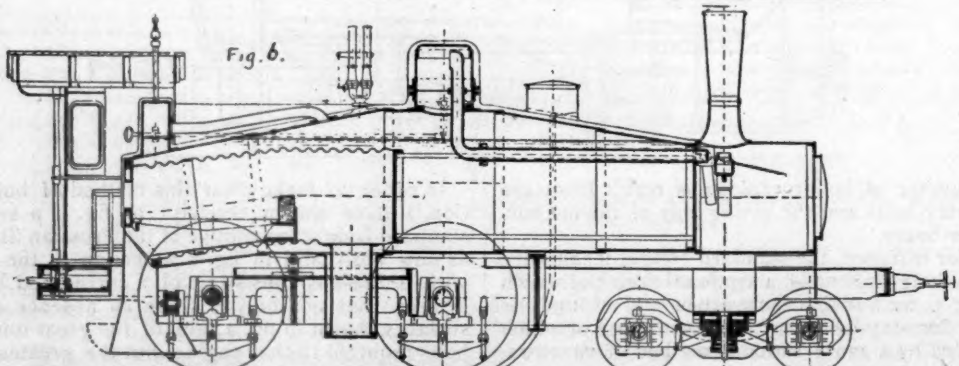


Fig. 6.

the same arrangement in all respects as the standard engine in fig. 1, the only change being in the substitution of the new boiler. It may be noted, however, that the use of the cylindrical boiler would permit in an engine of this

the advantages that may be gained. In both the boilers shown in figs. 2 and 3, in order to permit of a free circulation a small dome is placed on the back end, which is connected with the central part of the boiler by a pipe.

(It may be noted that this last device proposed by Herr Lentz seems to add a complication to the construction of the boiler, which is not altogether desirable, and which could be easily avoided.)

The total number of stay-bolts and stays which can be dispensed with by the use of the cylindrical fire-boxes in the locomotives shown is 445.

It may be objected that the lower part of the fire-box is closed and is curved. It is easy to provide a flat surface by a plate placed under the grate, as shown in fig. 2. Arrangements can also be made, as shown in figs. 2 and 3, for the removal of the ashes. A discharge-pipe for the ashes carried over the fire-bridge can be provided, as shown in fig. 2, while, at the same time, the outer casing will serve as a receptacle for sediment, or mud-drum. The boiler shown in fig. 2 has been so designed that it can be substituted for the standard boiler without any change in the engine, while the total heating surface is the same; at the same time the total weight of the boiler is less and the weight upon the axles will be much more evenly distributed, fig. 2 being free from much of the overhanging weight thrown upon the rear axle in fig. 1.

Where this arrangement is applied to a passenger engine, there is a further advantage that not only can the axles be much better arranged, but there will be room given under the boiler for cross-bracing of the frames, which in a quick-running machine is a very considerable advantage. In fig. 4 there is shown a section of the standard passenger locomotive on the Prussian State Railroads, which has four coupled driving-wheels, and here the inconvenience caused by the necessity of putting the rear axle under the fire-box is very well known. Fig. 5 shows the same locomotive having a boiler with cylindrical fire-box substituted for the ordinary boiler shown in fig. 4. In this case there are 450 stay-bolts which can be dispensed with by the use of the cylindrical fire-box, while the somewhat awkward construction of the fire-box required in the first case is entirely dispensed with. The boiler shown in fig. 4 is of the same general construction as in figs. 2 and 3, that is with an oval section in the center.

Fig. 6 shows a proposed improvement of this passenger engine intended for use on fast trains. In this case the driving-wheel base is somewhat longer, and a four-wheel truck is substituted for the single pair of leading wheels in figs. 4 and 5. It is believed that the experience of English and American Railroads has shown this construction to be much the best for a fast-running locomotive. In fig. 6 also the length of the boiler is somewhat increased. Herr Lentz also shows a very similar arrangement for a four-wheel switching engine or for a four-wheel light passenger engine, a type which is much used on German railroads for local service, and shows the peculiar advantage gained in this case in the longer wheel-base and the absence of that overhanging weight, which is always a great objection in the use of four-wheel locomotives.

In fig. 7 there is shown an eight-wheel freight engine of the standard pattern in use on the Gothard Railroad. This engine is of a type which is frequently employed for heavy freight service on the Austrian, Russian and Italian railroads, and for this pattern—which is closely allied to the consolidation engine in use in this country—the tubular fire-box is believed to offer many advantages. Not only in the engine shown in fig. 7 is there a great overhanging weight, but, in order to give room for all the wheels and to keep the fire-box clear of the axles as much as possible, it is necessary to make a very long boiler. By the use of the cylindrical fire-box, as shown in fig. 8, the length of the boiler can be diminished, the weight upon the driving-wheels much better adjusted, and some 560 stay-bolts can be dispensed with. The same advantage is also presented here as with the passenger engine, and that is that the frames can be braced together in a very much better fashion. The boiler shown in fig. 8 is of the same type as that presented by Herr Lentz in the other cases. All of these advantages are strongly insisted upon by the writer.

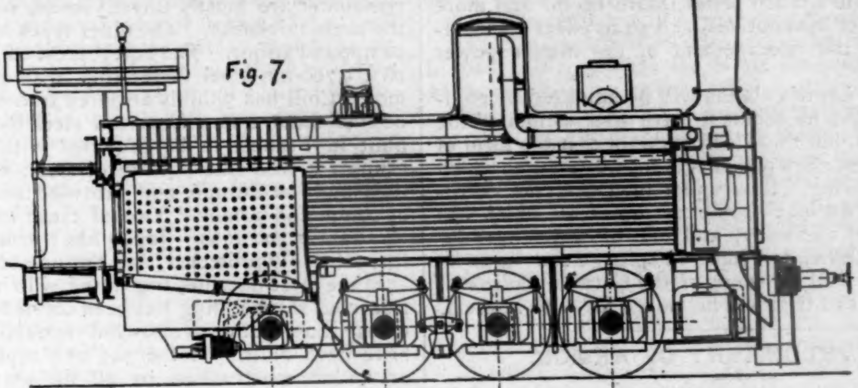


Fig. 7.

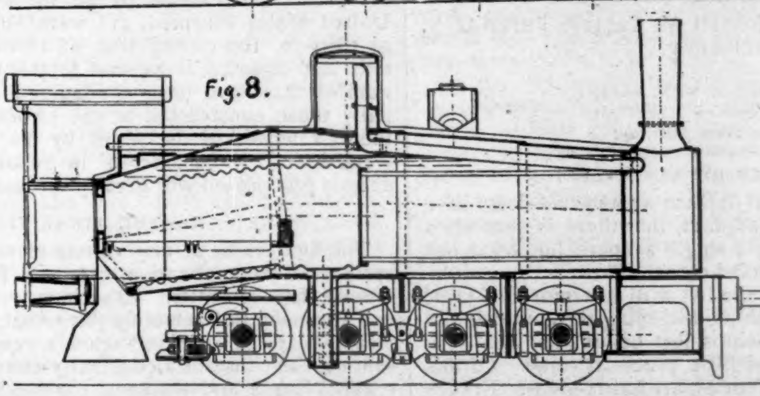


Fig. 8.

The cylindrical fire-boxes can be used both with outside cylinders or with inside cylinders and connections, to which some continental roads still adhere, although it may be said that the outside cylinder is much more common in other European countries than in England or France. In either case the advantage of the better arrangement of weight on the wheels can be obtained.

In conclusion, Herr Lentz presents the following claims for the advantages to be gained by the adoption of the cylindrical fire-box:

"1. The first cost of the engine would be lower by an amount varying according to the size of the engine, but given for an average German engine at from 4,000 to 5,000 marks (from $1,000 to $1,250).

"2. The cost of repairs and the time lost in repairs will

be very much reduced, and consequently the locomotives can be better utilized and the total amount and cost of the motive power diminished.

"3. Owing to the greater strength of the cylindrical fire-box and its greater resistance to pressure, the working pressure carried can be increased considerably, and greater advantage will be offered for the use of compound locomotives.

"4. Better consumption of the fuel, will be secured by the greater ease with which the grates can be cleaned and by the use of the combustion chamber, thus effecting a saving of fuel.

"5. Economy in fuel can also be secured from the fact that the fire-box shell remains clear of incrustation, and that the boiler can be much more easily washed out and sediment prevented.

"6. Periodical examinations of the boiler, which in the ordinary construction are required in order to see that no stay-bolts or stays are broken, will not be needed frequently; but it will only be necessary to examine the fire-box shell and rings at longer intervals.

"7. By the adoption of the circular form of fire-box it is possible to obtain a much better, more useful and more economical force of locomotives, and so to effect a considerable saving in the management of the motive power department."

Not all of Herr Lentz's claims will be admitted by engineers generally, and he seems to have over-estimated the saving in first cost, but there is little doubt that the form of boiler which he describes presents many advantages which are worth considering. It is understood that the corrugated cylindrical fire-box—some examples of which are already in trial in Germany, and one of which was described in the JOURNAL for June, 1889, page 272—is to be given a thorough trial on some of the German railroads, and the results of this trial will be looked for with interest.

## THE DEVELOPMENT OF ARMOR.

BY FIRST LIEUTENANT JOSEPH M. CALIFF, THIRD U. S. ARTILLERY.



(*Continued from page* 104.)

### IX.—FOREIGN ARMOR-CLAD FLEETS.

IN the matter of national defense armor-clad fleets have become so important an adjunct, that there is scarcely a civilized power possessing a single seaport, but what has made a beginning in iron-clad construction.

England naturally leads the list with an armor-clad fleet, built and building, of 81 ships, including those in colonial service, and the 8 battle-ships just begun, as well as a number of obsolete craft of little practical value. Of this number more than one-half, or 45, are battle-ships. France follows with 61 names of all descriptions upon her navy list, 24 of which are battle-ships. Although Germany is credited with 30 armored ships of different kinds, a very large proportion of these are of obsolete types, of iron, and with comparatively thin iron armor. A single steel 5,200-ton barbette ship, with a maximum thickness of 13 in. of compound armor, is the only modern type of iron-clad upon her list.

Of the 41 armored ships of Russia, more than one-half are coast-service vessels, or armored gunboats of small tonnage, but among the remainder she has 3 steel barbette battle-ships of the first class, of the type of the *Catherine II.* These vessels have something over 10,000 tons displacement; a water-line belt of 16-in. armor, and a central citadel enclosing three barbette towers, and protected with 14-in. armor.

Of Italy's 21 armor-clads, completed or on the stocks, 10 are first-class battle-ships, with an aggregate tonnage of more than 123,000 tons. Austria has an iron-clad fleet of 14 ships. All are provided with a water-line belt, and all but two are of old types, with from 5 to 9 in. of plating. Her most formidable fighting representative is a 7,000-ton barbette ship of steel, with 12 and 11 in. armor on belt and barbette respectively. The Netherlands have a fleet of 23 armored ships, all of old type and of iron. All but two of this number are coast-service vessels or armored gunboats, and none have a greater thickness of armor than 11½ in. of iron.

Sweden has 16 iron-clads on her navy list. These are all coast-defense vessels, except two, are of iron, and of obsolete types. The two exceptions are 3,000-ton turret ships of steel, and have a maximum thickness of armor of 11½ in. Denmark has 12 protected ships of all kinds. The larger part have iron-armor of from 2½ to 8 in. She is building a 2,400-ton torpedo-ship, with 4 in. deck and 8 in. battery armor of steel. Norway has but 4 iron-clads—all of old type.

Turkey has a fleet of 19 iron-clads. None of these have been launched since 1875. The most powerful is a 9,000-ton ship, with a maximum thickness of 12 in. iron-armor. The greater part are thinly armored. Of other European powers, Greece has 4 iron-clads and Portugal 1, while Roumania brings up the rear with a single protected cruiser.

Of the South American Republics, Brazil has 12 iron-clads, including 3 river monitors, with 4½ in. of armor. The remainder are mostly turret vessels, with plating of about the same thickness. The older types have iron, the newer compound armor. The best representative of Brazil's navy is a 5,700-ton steel turret ship, with 11 in. compound armor. Chili has 3 thinly armored iron-clads of old design; besides these, a new 6,900-ton steel barbette ship is being built in France, to be provided with 12-in. armor. Of China's 4 iron-clads, 3 are of steel, of recent construction, built in Europe, and provided with from 8 to 14 in. of compound armor. Two of these have a displacement of about 7,500 tons. Japan has 7 armored vessels on her list, all thinly protected, and but one of recent design.

In the three decades, beginning with 1860, during which iron-clad shipbuilding has been carried on, it is impossible to say how many armor-clad vessels of all descriptions have been built. Of the 343 now reported as in service, or under construction, by all the maritime powers, the United States excepted, 111 were built during the decade of 1860-70, 107 during that of 1870-80, and 115 during that just closed. If we add to this the very considerable number that have been condemned and dropped, principally those constructed in the sixties, we see that during the first decade of the series by far the greater number were built. If considered in relation to tonnage, the decade just passed will greatly surpass either of the others.

### X.—THE FINAL TEST.

The final value of any variety of armor-plate, or of any system of its application, can only be determined by the crucial test of battle. Experiments at the practice-butts can approach but remotely the actual conditions of battle. Armor-plate of any kind upon a vessel under way, presenting each instant a constantly-changing target, both as regards angle and distance, enveloped in smoke and uncertain in its outlines, and upon a yielding platform, will behave in an entirely different way from the same quality and thickness of metal placed against a rigid backing and fired at with all the care possible to long preparation. Added to this, the personal equation of the man behind the gun must be considered; he may be cool and collected, but more likely excitement, or fear, or both, will greatly reduce his efficiency. All of these conditions will favor the armor-plate, and we are safe in giving it a considerably increased value over that demonstrated on the trial ground.

Outside of the United States, during the three decades of iron-clad shipbuilding, there have been few opportunities of bringing armor to this test. Even the lessons learned during our Civil War, of which mention will be made hereafter, or the few battle-tests that have since occurred, can now have but a general value, since not only the nature of the armor-plate itself, but the manner of its distribution, as well as the character and power of the projectiles brought against it, have all greatly changed within a very recent period.

The battle of Lissa, in 1866, gave the first opportunity of testing iron-clad against iron-clad. The Austrians brought into action 7 iron-clad frigates, in addition to

a fleet of 14 wooden ships. Against these the Italians mustered 8 iron-clads, and a double-turreted sea-going monitor. The Austrian ships had complete armor protection along the water-line and for the main-deck battery, of from 2½ to 5 in. in thickness. The Italian ships had likewise water-line protection, but 3 of them were poorly protected at the ends. The armor varied from 3 to 4½ in. in thickness. The armament of the 7 Austrian iron-clads aggregated 173 guns, 74 of which were 6-in. breech-loading rifled cast-iron Wahrendorf guns, the others 48-pounder smooth-bores. The Italians brought something over 200 guns into action, all rifled and ranging in caliber from the 6½-in. Cavalli breech-loader to the 9-in. Armstrong muzzle-loader.

Early in the action the steering-gear of the Italian iron-clad *Re d' Italia* was shot away, and while in this disabled condition she was rammed and sunk by the *Ferdinand Max*, the Austrian flagship. The *Palestro*, another of the imperfectly protected Italian ships, was set on fire, and subsequently blew up. The Italians lost two ships and nearly 700 men killed and wounded ; the Austrian loss was less than 150.

The armor of the Italian ships is said to have been hard and brittle, and was evidently inferior to that of the Austrians. The Austrian report says that their armor behaved remarkably well. The 9-in. rifled shot from the Armstrong guns failed to get through even 4½ in. of plate. It also says that the great loss in killed and wounded on the Italian ships was due in a great measure to the fact that the Austrian projectiles struck the edges of the plating near the ports, sending showers of fragments from the brittle metal among the gunners.

In 1868, during the war between Brazil and Paraguay, a Brazilian single-turreted river monitor, armored with 4½-in. side and 6-in. turret armor, in solid plates, attacked at short range Paraguayan batteries armed with 32-pounder Whitworth rifles, and 68 and 120-pounder smooth-bores. The monitor is reported to have been struck some 200 times. Besides being badly damaged about the turret, 12 shot penetrated the side-armor, and two found their way through that of the turret. Considering the shortness of the range and the incessant pounding it received, the armor-plate may be said to have behaved well, although hardly equal to the work imposed upon it.

At Cartagena, Spain, in October, 1873, a duel took place between the insurgent iron-clad *Numancia* and the Spanish ship *Vittoria*, both of something over 7,000 tons. The former had 5-in. armor, and was armed with 7 and 10-in. Armstrong guns ; the latter, 5½-in. armor and an armament of 8 and 9-in. Armstrongs. During the engagement the armor of the *Numancia* was struck 14, and that of the *Vittoria* 8 times by heavy shot, but the projectiles failed to penetrate, and no great damage was done.

In the action between the turreted iron-clad *Huascar* and the unarmored cruisers *Shah* and *Amythest* off the Peruvian coast, in 1877, the 64-pounder shell of the English ships were found useless against the thinnest armor-plate of the *Huascar*. The *Huascar* had 4½ in. of solid armor on the sides amidships, tapering to 2 in. at the bow and stern, and 5½ in. solid plates on her turret, all well backed with teak.

Two years later the *Huascar* had a fight with the Chilian iron-clad corvettes, *Encalada* and *Cochrane*. These had a water-line armor-belt of from 4½ to 9 in. in thickness, and battery armor of from 6 to 8 in. The armament consisted of six 9-in. muzzle-loading Armstrong rifles. The *Huascar* mounted two 10-in. guns of the same pattern in her turret.

The fight lasted an hour and a half, at the end of which time the *Huascar* had lost her four senior officers, and 76 out of a crew of 200 men, when she surrendered. During the fight the armor of the *Huascar* was struck 20 times by heavy shot, 10 of which perforated the armor, while five glanced off. Many shots took effect on the unarmored parts, principally the stern. The 5½-in. turret armor was pierced twice, the 4-in. armor once, the 3-in. armor four times, the 2½-in. armor twice, and the 2-in. armor once. The projectiles which perforated the turret armor and partially disabled the guns were fired by the *Cochrane* at a range of about 12 yards.

The gunnery on the *Huascar* was poor. The *Encalada* received no injury. The *Cochrane* was struck twice. A 10-in. Palliser chilled shell, fired at a range of 600 yards, struck her armor at an angle, indenting it to a depth of 3 in. ; another, striking on the quarter above the water-line armor, penetrated and burst, wounding 10 men. In addition to the loss of more than a third of her strength, the *Huascar* was three times disabled by the enemy's fire, many times set on fire, her turret was jammed, and one of her turret guns disabled. Although her armor is said to have been of very fine quality, it was of insufficient thickness to cope with the 9-in. projectiles of her adversaries, delivered at close range. One writer, speaking of this, says : "The armor in this case was only a great disadvantage to her. It served to explode the enemy's projectiles ; . . . the backing and inner skin only served to increase the number of fragments, which were driven into the interior of the vessel with deadly effect. . . . The explosion of each shell—and each shell which pierced the armor exploded—set the ship on fire in a new place." It should be added that the armor-plate was of soft wrought-iron of English manufacture. Had it been of any of the hard-faced modern varieties, it is safe to say that not a single hollow projectile would have gotten through.

The bombardment of Alexandria by the English fleet, in July, 1882, affords the latest example of the behavior of armor-plate under fire. Although the Egyptian fortifications were largely of a very inferior quality of masonry, the guns mounted therein were many of them of the best type of English manufacture, provided with an abundance of the best ammunition : 27 Armstrong muzzle-loading rifles figure in the list, together with smooth-bores and mortars enough to bring the total armament up to over 200 guns. The English brought against these seven iron-clads of various tonnage, from the *Penelope* of about 5,000 tons to the 12,000-ton *Inflexible*, with armor ranging from the 6-in. plating of the former to the 24-in. of the latter. The Egyptians stood to their guns manfully, and only after a 10 hours' bombardment, at distances from 700 to 1,500 yards, and not until many of their guns were disabled and tons of their rotten masonry had been knocked about their ears, were the batteries silenced.

On the *Alexandra* the armor was struck a number of times without inflicting any injury, but above the armor-plating 24 shot and shell found their way, causing much damage to cabins, lower deck, etc. Upon the *Invincible*, *Sultan*, and *Superb*, the blows upon the armor-plating in no case did more than indent the metal, and, in one or two instances, slightly start it from its backing, but their upper works and top-hamper suffered considerably. The fighting qualities of the ships were, however, in no way injured.

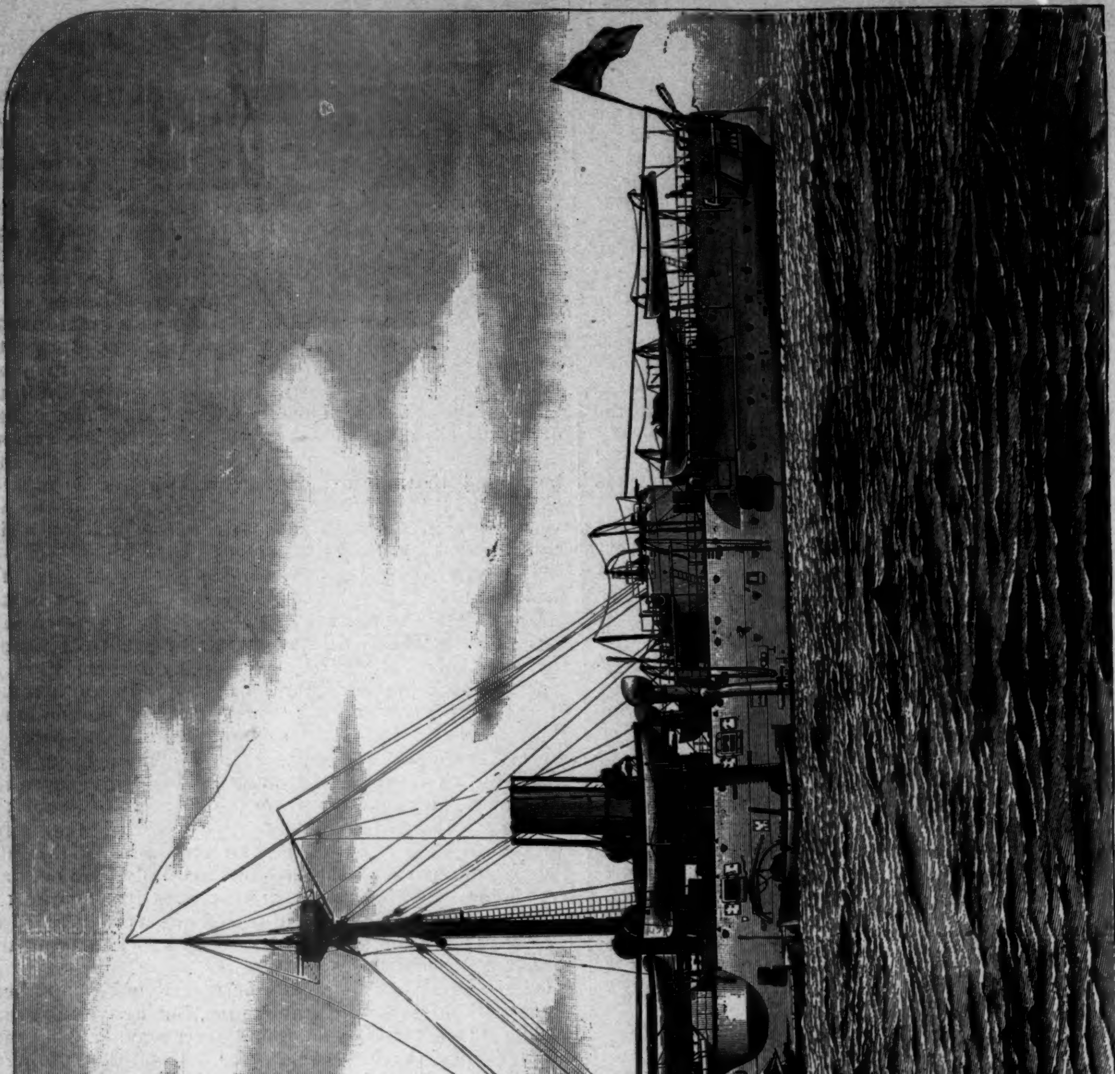
The report upon the injuries suffered by the *Inflexible* was not made public. Besides considerable damage to her superstructure and upper works, she is said to have been pierced under water, probably below the armor-belt, which necessitated her subsequent docking. The losses were insignificant—6 men killed and 27 wounded.

(TO BE CONTINUED.)

## AN ENGLISH ARMORED CRUISER.

THE accompanying illustrations—from the London *Engineer*—show the *Impérieuse* of the English Navy. The large engraving is taken from a photograph of the vessel while at anchor ; of the smaller cuts, fig. 1 is a side view, fig. 2 a deck plan, fig. 3 a midship section, and fig. 4 a section outside of the armor-belt.

The *Impérieuse* and her sister ship, the *Warspite*, which are classified as armored cruisers of the first class, represent a type of war vessel totally distinct from the citadel battle-ships which preceded their introduction into the English Navy, or the barbette *Admirals* and turret battle-ships which followed them. They are peculiar in having four distinct protected positions for heavy guns, separated from one another, and unconnected by means of vertical armor or other contrivance. Each of these positions is provided with an elevated barbette, sheathed with 8-in. composite armor, and mounting a single 24-ton, 9-in.



FIRST-CLASS ARMORED CRUISER "IMPÉRIEUSE," FOR THE BRITISH NAVY.

breech-loading steel gun, possessing a very considerable arc of training. At a lower level is placed a large number of guns of smaller caliber—6-in. steel breech-loaders—sheltered to some extent from the fire of the heavy guns. This arrangement has been adopted to a great extent from that followed by the French in the *Admiral Duperré*, the *Magenta* class, etc. It has its advantages in the division of the heavy-gun positions, so that it would be impossible to wreck them all simultaneously by a single adroitly-directed shot, as might take place in the central citadel battle-ships; but it is faulty, in that no armored connection exists between these positions, either for the secure transport of ammunition or the protection of gun detachments and 140 ft. long. It was to have been 3 ft. 3 in. above and 4 ft. 9 in. below water-line, but the alterations made during construction of the vessel made a difference in her trim, and it was found, when completed, that the lower line of her belt was 6 ft. 7½ in. below water-level, while the upper one was only 1 ft. 4½ in. above. She has, however, a steel armored deck at the top of the belt which would prevent projectiles penetrating into the engines, boilers, or magazines, even if they succeeded in getting through the sides of the *Impérieuse* when she heeled over toward her enemies. But it cannot be denied that the armored belt was never intended to be placed so low down, and the weakness of a design, which was so ill provided

FIG. 1.

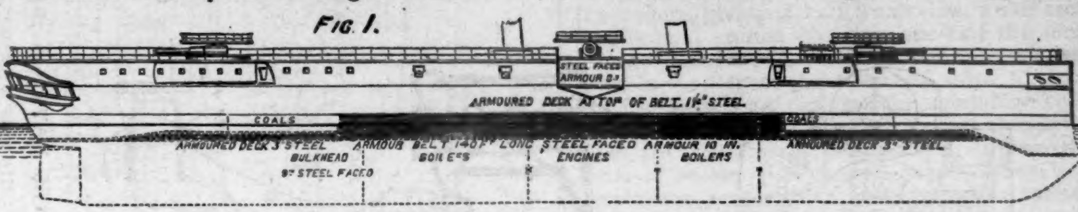
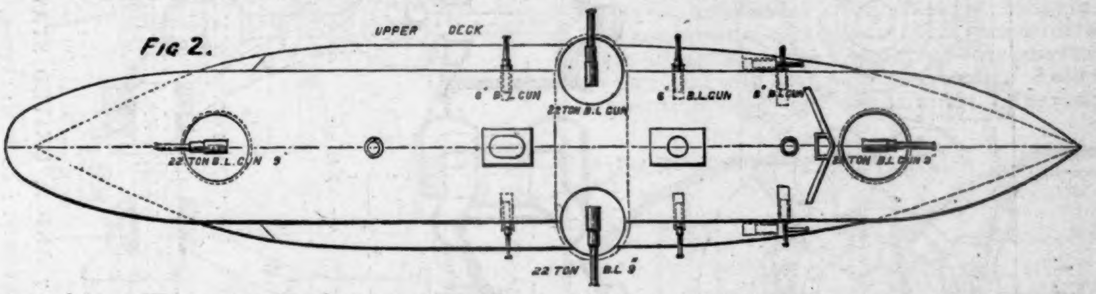



FIG. 2.




passing to and fro. We must not omit to mention, however, that in it the first practicable arrangement is found for the auxiliary armament, the lesser batteries being at a lower level than the others, and thus the whole of the guns are capable of being worked independently in the heat of action, without any danger of their several lines of fire fouling one another. To provide a safe and sufficient distance between the guns of the auxiliary armament has been one of the most troublesome problems that Mr. W. H. White had to solve in the designs for the new battle-ships now in course of construction.

The *Impérieuse* is a twin-screw steel vessel, sheathed with wood, and coppered for tropical service. Her displacement is 8,400 tons, length, 315 ft., and beam, 62 ft.

FIG. 3.

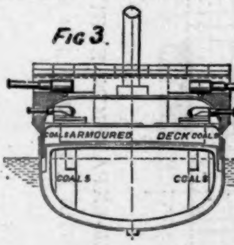
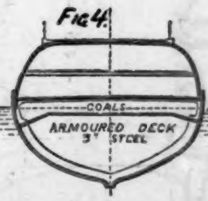



FIG. 4.




She was completed at Portsmouth in 1886. Her engines are of the triple-expansion type, by Maudslay & Company, and of 10,000 H.P. She was designed to carry 400 tons of coal at her normal draft, with power to stow 900 tons when required; but it was subsequently found possible to stow as much as 1,130 tons. With this she could steam 7,000 knots at a 10-knot speed. But this extra coal, and her altered weights, would immerse her nearly 2 ft. below the water-line as designed, which gave her originally an extreme draft of 25 ft. 5 in. At present her draft is recorded as 27 ft. 4 in. This is, of course, with all weights on board. The removal of the masts and sails, she having been at first brig-rigged, and the substitution of a single fighting mast for the others, made a difference of 3 in. only in her draft, 100 tons weight being saved by this contrivance. A full speed, under forced draft, of 16¾ knots, was obtained at trial, this being three-quarters of a knot more than was anticipated by the original designers. With a smaller quantity of coal stowed she would rise about 1 ft. The *Impérieuse* has an armored belt 8 ft. wide, 10 in. thick, with a margin of buoyancy against possible alterations in trim during construction, is only too apparent. Fortunately the "Board margin," as it is called, which is to be considered in all future designs, will give ample scope for any fresh ideas which may crop up during the growth of vessels from their keels to completion. There are armored bulkheads of compound plate 9 in. thick at both ends of the belt, and from the base of these the steel armored deck extends to stem and stern; all the vitals are below the steel deck. The armament of the *Impérieuse* consists of four 9.2-in. 24-ton guns, six 6-in. 5-ton guns, 10 Nordenfelt guns, three torpedo-ports, and four 6-pounder quick-firing guns. The heavy guns are protected by steel shields upon the summit of the barbettes, behind which the gun detachments are partially sheltered. The position of the guns, auxiliary battery, belt, etc., can be best seen by a reference to the cuts which give the whole in detail—elevation, plan, and sections.

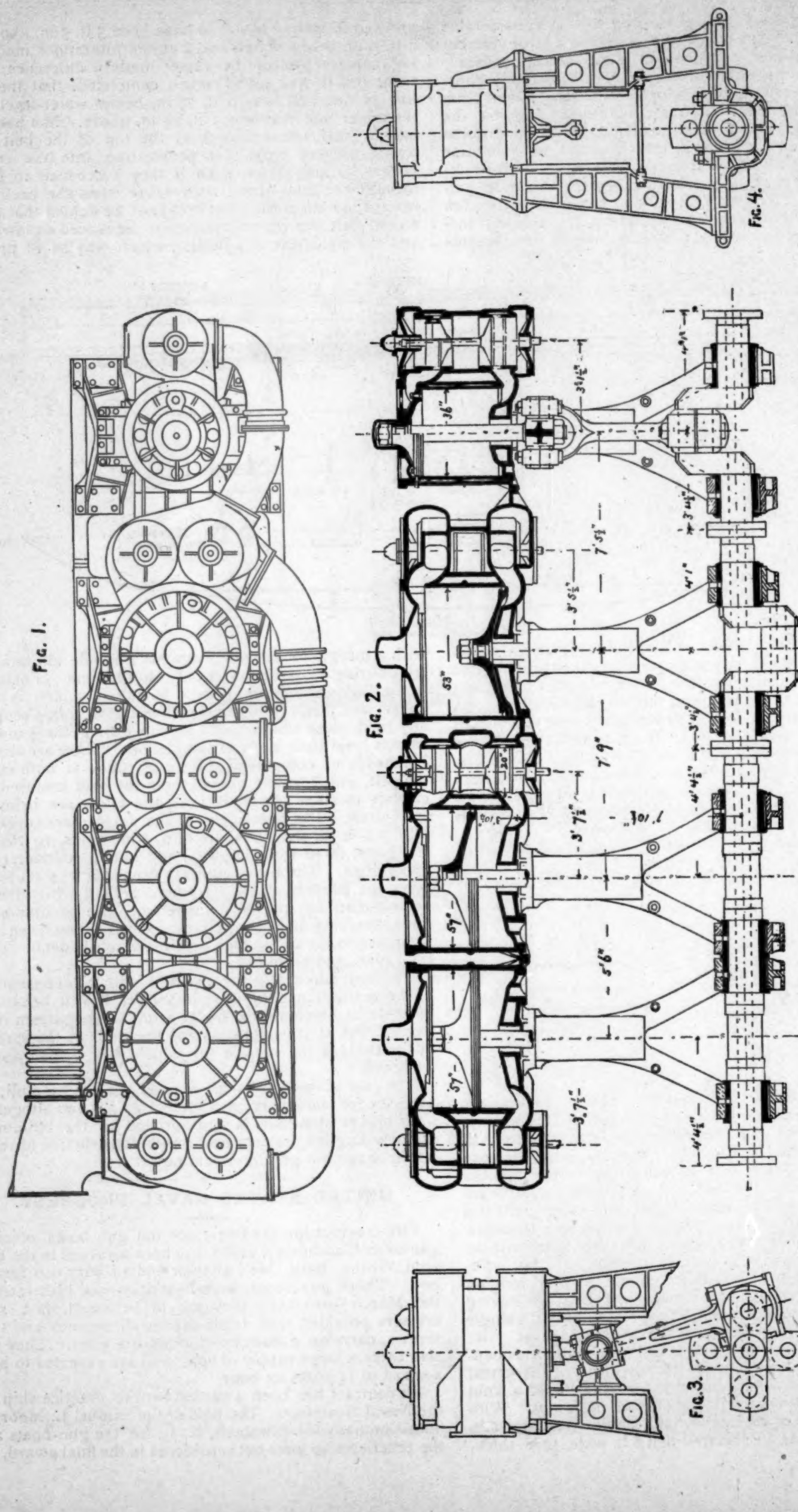
One fault found with these vessels is that, in consequence of the ventilation being very imperfect, it will be scarcely possible to employ them under a full head of steam in the tropics, out of consideration for the lives of the stokers; and yet this is the service for which they were specially designed.

The cost of the *Impérieuse* was $2,032,900 for hull, and $552,200 for machinery, or a total of $2,585,100 altogether, a far higher sum than is appropriated for the building of the new English cruisers now under construction of rather less tonnage but greater steam power.

## UNITED STATES NAVAL PROGRESS.

THE contract for the two 1,000-ton gun-boats, officially known as Gun-boats 5 and 6, has been awarded to the Bath Iron Works, Bath, Me., at their bid of $637,000 for the two. These gun-boats were described and illustrated in the March JOURNAL; they are to be small, fast, steel cruisers provided with triple-expansion engines and twin screws, carrying a battery of rapid-fire guns. They will also carry a large supply of coal, and are expected to have a speed of 14 knots an hour.

No contract has been awarded for the practice ship for the Naval Academy. The bids of the Samuel L. Moore & Sons Company, of Elizabeth, N. J., for the gun-boats and the practice-ship were not considered in the final award, the




TRIPLE-EXPANSION ENGINES FOR CRUISERS NOS. 7 AND 8, UNITED STATES NAVY.

DESIGNED BY THE BUREAU OF STEAM ENGINEERING, NAVY DEPARTMENT: G. W. MELVILLE, CHIEF OF BUREAU.

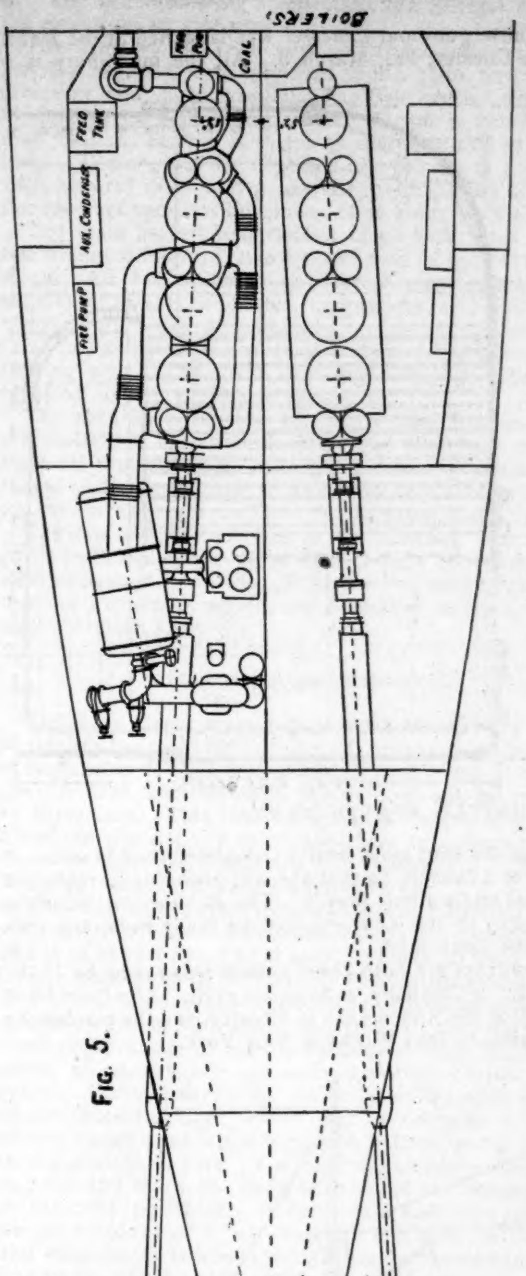



Fig. 5.

ARRANGEMENT OF ENGINES, CRUISERS NOS. 7 AND 8, UNITED STATES NAVY.

Department having decided that the works of that Company were not at present in a condition to build the vessels without delay.

### ENGINES FOR THE 3,000-TON CRUISERS.

In the March Journal a descriptionwas given of Cruisers Nos. 7 and 8, generally known as 3,000-ton cruisers. As there noted, these ships are to be twin-screw steel cruisers with heavy protective deck, having a length of 300 ft., a breadth of 42 ft., a mean draft of 18 ft., and a displacement of 3,183 tons. They will carry one 6-in. and nine 4-in. rapid-fire guns, with a heavy secondary battery.

The accompanying illustrations, which are taken from the Report of the Bureau of Steam Engineering, show the engines designed by the Bureau for these vessels. In these illustrations, fig. 1 is a plan of one of the engines; fig. 2, a longitudinal section; fig. 3, an end view from the after end, with the frame broken away to show the connecting-rod and cranks; fig. 4, an end view from the forward end; fig. 5, a plan showing the arrangement and position of the engines in the ship; figs. 6 and 7, cross-sections showing the position of engine and boilers. Fig. 8 shows one of the boilers, giving a half front view, a half section and a longitudinal section showing one-half the length of the boiler. The description which follows is substantially that given in the Report of the Bureau.

These vessels are designed for a very high speed, and in consequence very powerful engines are needed to secure it. They are to be twin-screw, vertical, triple-expansion engines of 10,000 H.P. at full power, when making 164 revolutions with 160 lbs. pressure. The cylinders are 36 in., 53 in., and two of 57 in. diameter, by 33 in. stroke. Two low-pressure cylinders are fitted, because of the limited space athwartship, which would not have permitted a good arrangement with a single large cylinder. Each engine is in a separate water-tight compartment. The piston-valves

Fig. 6.

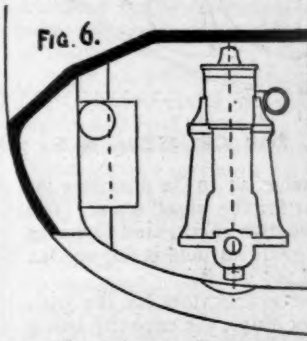
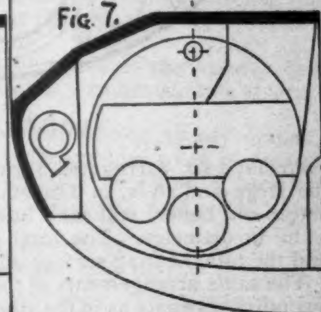


Fig. 7.



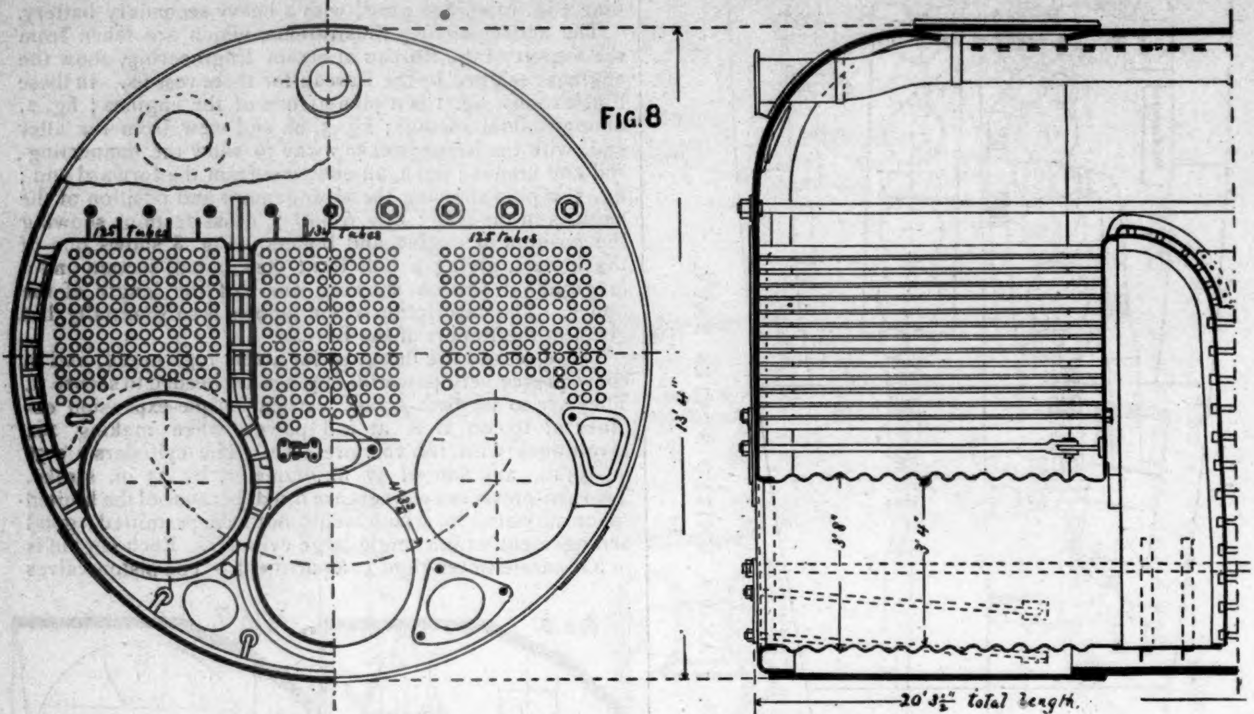
are all 20 in. in diameter, there being one for the high-pressure cylinder, two for the intermediate cylinder, and two for each low-pressure cylinder. They are all worked from Stephenson double-bar links. Provision is made in these engines, as in all the Bureau's recent designs, for adjusting the point of cut-off for each cylinder independently of the others, by making the attachment of the suspension-rod of the link to the arm on the reversing-shaft adjustable. The crank-shafts are in three sections, the two forward ones being interchangeable, and the after ones reversible. The two low-pressure cranks are placed opposite each other, as are the high-pressure and the intermediate cranks, the plane of these two being at right angles to that of the two low-pressure cranks. The journals are $13\frac{1}{2}$ in. in diameter and the crank-pins $14\frac{1}{2}$ in. in diameter, all with 6-in. axial holes. The thrust-shafts will be 13 in. in diameter with $6\frac{1}{2}$-in. axial holes, and the propeller shafts $13\frac{1}{4}$ in. in diameter with $6\frac{1}{2}$-in. and 6-in. axial holes. The propellers will be three-bladed, of manganese bronze or equivalent metal, and about 14 ft. 6 in. in diameter.

The condensers will be cylindrical, of composition, 5 ft. 8 in. in diameter, and the tubes 11 ft. 6 in. long, each having a cooling surface of about 6,990 sq. ft. A valve is fitted in the exhaust-pipes from the low-pressure cylinders to shut them off when the condenser is used for auxiliary purposes. Each centrifugal circulating-pump will have a capacity of 9,000 galls. per minute when pumping from the bilge. There will be two vertical, single-acting air-pumps for each condenser, $18\frac{1}{2}$ in. in diameter and $16\frac{1}{2}$ in. stroke, worked by a compound engine.

There will be steam starting-valves, steam-actuated throttle-valves, steam and hydraulic reversing-engine, turning-engine, work-shop machinery, and the usual auxiliaries.

There will be four double-end and two single-end boilers of the usual return tubular type, all built of mild steel.

Two of the double-end boilers (fig. 8) will be 13 ft. 4 in. diameter and two 14 ft. 6½ in. diameter, all 20 ft. 3½ in. long. The shell-plates will be 1 5/32 in., 1 15/64 in. and 57/64 in. in thickness respectively. The double-end boilers will




BOILER FOR CRUISERS NOS. 7 AND 8, UNITED STATES NAVY.

each have six corrugated furnaces 44 in. in diameter for the large and 40 in. in diameter for the small ones. The single-end boilers will each have two corrugated furnaces 42 in. in diameter. The total grate surface is 607 sq. ft., and the total heating surface 20,167 sq. ft.

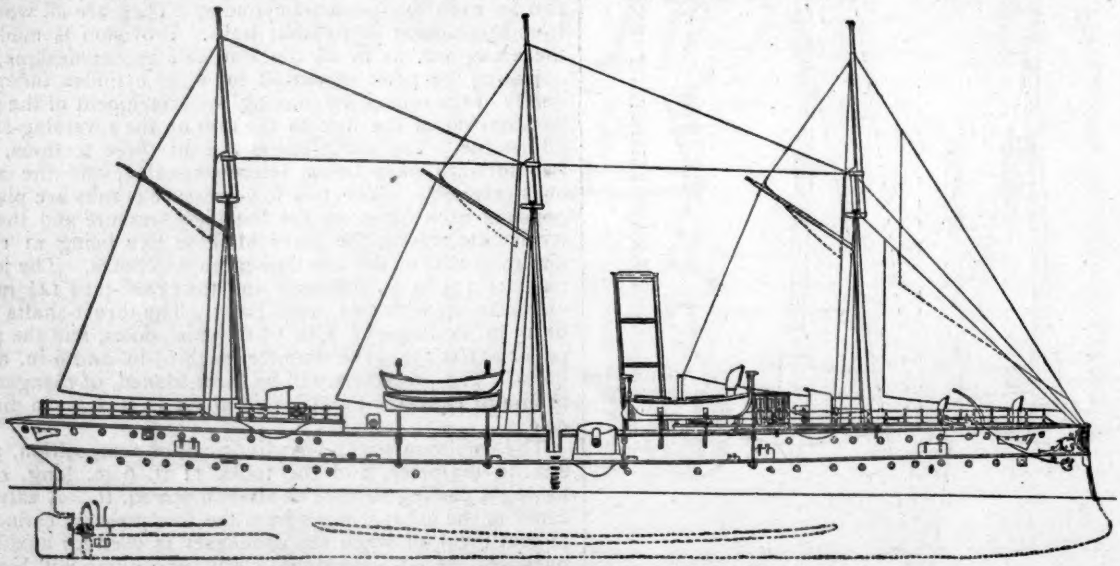
The same arrangements of the evaporators for the various purposes exists as in the other ships, the capacity being 5,000 galls. of potable water per day.

As heretofore noted, the bids received for these ships were all in excess of the amount appropriated by Congress for their construction. It was, therefore, decided to build them in the navy yards, and one of the ships is now under construction in the New York Yard and the other in the Norfolk Yard. The machinery for both vessels is being built at the New York Yard, work being now actively in progress.

### LAUNCH OF THE "CONCORD."

The new gun-boat *Concord* was launched at the Roach yard in Chester, Pa., March 8. All the machinery is in place, and the ship more nearly completed than is usual at the time of a launch, so that she will probably be ready for the official trials about May 1. The *Bennington*, which is a sister ship to the *Concord*, will be ready to launch very soon at the same yard.

The contract for both these vessels was taken by N. F. Palmer, Jr., & Company, at $490,000 each. The hulls have been built at the Roach yard in Chester, and the machinery at the Quintard Iron Works in New York.



GUNBOAT "CONCORD," UNITED STATES NAVY.

The *Concord* is a light, unarmored cruiser or gun-boat of steel, divided by water-tight bulkheads into numerous compartments. The chief dimensions are: Length on load water-line, 226 ft.; beam, 36 ft.; depth, 18 ft. 9 in.; draft, 13 ft. forward, 15 ft. aft, or 14 ft. mean; displacement, 1,703 tons. The ship will carry three masts with fore-and-aft rig, and will have a sail area of about 6,350 sq.

ft. The accompanying illustration is a general sketch of the elevation, or side-view.

The *Concord* has two vertical, direct-acting triple expansion engines, with cylinders 22 in., 31 in. and 50 in. in diameter and 30 in. stroke. The twin screws are three-bladed, 11 ft. 6 in. in diameter. Steam is furnished by four boilers, each 9 ft. 6 in. in diameter and 17 ft. 6 in. long. The engines are expected to work up to 2,200 H.P. with natural draft and 3,300 H.P. with forced draft, and the contract speed at full power is 16 knots per hour.

The main battery will consist of six 6-in. rifled cannon, two mounted forward, two aft and two in sponsons amidships. All are mounted on central pivot mounts, with segmental shields to protect the gunners, and have an arc of fire of 70°. The secondary battery includes two 57-mm. (2.24-in.) and two 37 mm. (1.46-in.) revolving guns and one Gatling gun. There are also eight torpedo-tubes: one forward, one aft and six in broadside.

The ship is lighted by electricity, and has an electric search-light. Two independent light plants are provided. Especial attention has been given to ventilation of fire-rooms and quarters, and to providing comfortable quarters for the officers and crew, who will number about 150 in all.

The cruiser *Newark* was to be launched at the Cramp yards in Philadelphia about March 17. The *Newark* is a steel cruiser of 4,000 tons displacement, much resembling the *San Francisco*, which was described in the December number of the JOURNAL.

### THE NEW ARMORED CRUISER.

The Navy Department has issued a preliminary circular in relation to the armored cruiser provided for in the Act of September 7, 1888, for which the sum of $3,500,000 was appropriated, and for which propositions will be invited at an early date. This circular is issued beforehand so as to afford an opportunity to shipbuilders to submit independent designs for both hull and machinery. Secretary Tracy is desirous of having such designs.

This ship is to have a displacement of about 8,150 tons, with hull divided into numerous water-tight compartments. She is to have a speed of at least 20 knots an hour for four hours, which will be remarkably fast for an armored ship. The main engines are to be triple-expansion and four in number, two on each shaft, so arranged that the two forward engines can be readily uncoupled from the after engines, so as to make her an economical cruiser at low speed. Vertical armor is not to be relied upon so much as the protective deck, which will be armored 6 in. thick on the slopes over machinery and boilers, and 3 in. thick on the horizontal part. Forward and aft of the machinery, to stem and stern, the deck is to be, at the thinnest part, at least 2½ in. thick. If there is a sufficient margin of weight to admit of it, an armored belt 3 in. in thickness and extending 3 ft. above and 3 ft. below the normal water-line for the whole length of the ship will be carried. Within this armor belt a belt of woodite or other water-excluding material will be carried. The armored deck will be 1 ft. above the water-line amidships, and will slope to 5 ft. below the water-line at the sides. The conning-tower is to be protected by 7½ in. of armor.

The ship is to carry a battery consisting of four 8-in. breech-loading guns and sixteen 4-in. rapid-fire guns, with a secondary battery of four 6-pounders, four 3-pounders and four 1-pounder rapid-fire guns, four revolving cannon and four small machine guns. The 8-in. guns are to have a minimum horizontal train of 300°. There are also to be six torpedo tubes. The 8-in. guns are to be mounted in barbette turrets, having 10-in. armor, and are to be provided with revolving shields not less than 7 in. thick. The gun positions and ammunition-hoists are further to have cone-shaped armor not less than 5 in. thick, and the 4-in. guns are to have shields not less than 4 in. thick. The smaller rapid-fire guns are to be protected by extra heavy shields, and by thick plates on the sides.

The vessel is to carry 500 tons of coal at her normal displacement, and to have a total coal capacity of not less than 1,150 tons. The principal features of this cruiser are thus to be great speed, high coal endurance giving a great cruising range and the strength of the secondary battery.

## INTEROCEANIC COMMUNICATION BY WAY OF THE AMERICAN ISTHMUS.

By Lieutenant Henry H. Barroll, U.S.N.

### I.—HISTORICAL NOTES.

INTEROCEANIC communication between the Atlantic and Pacific oceans has occupied the minds of navigators since the discovery of the New World.

Columbus sought, not to give to his sovereigns a new world, but an uninterrupted water-highway to the East Indies, which for 3,000 years had been the storehouses of Europe, and the tales of whose splendor only reached Western Europe after a weary caravan journey of 300 days.

Succeeding navigators, therefore, instead of devoting themselves to the settlement of the new continent, sought diligently some way by which this barrier might be avoided.

Columbus ever believed that this continent adjoined Asia; and he persistently searched the whole coast, from Honduras to the Spanish Main, in the expectation of finding another Straits of Gibraltar, leading into another Mediterranean Sea, whereby his sovereign's ships might reach the mouth of the Ganges.

After the discovery of the Pacific in 1513, and later of the passage through Magellan's Straits by their illustrious namesake, a route to the West was shown, yet not a satisfactory one; and succeeding explorers examined every foot of the coast on both sides of the two Americas before mankind would concede that the two great oceans had not some connecting channel-way through this mighty stretch of lands.

After all efforts to discover a natural passageway had proven unsuccessful, the question then became one of forming an artificial channel.

Commerce demands uninterrupted and speedy transit. Centuries of experience have shown that when places are accessible by water, great disparity in distance does not enable transportation by land to compete with water transportation.

The fact that the general drift of the trade-winds and the equatorial currents from the Old World, westward, was stopped by this barrier, increased its importance, and the cutting through of the obstructing hills became a work of the greatest necessity.

The earliest project for a canal was that of the Spanish historian Gomarra, who, in 1551, urged upon Philip II. of Spain to unite the oceans by some one of the three routes now occupying the attention of the world—Tehuantepec, Nicaragua, or Panama.

Philip, however, was too much occupied with European affairs, and Spain was even then on her downward path, and no notice was taken of Gomarra's suggestion.

### II.—PATTERSON'S ATTEMPT AT COLONIZATION.

The first real shape to any idea of transit across the Isthmus was given in the suggestion of William Patterson, the founder of the Bank of England, who attempted, in 1695–96, to establish a Scotch Company in opposition to that grand monopoly the East India Company.

Patterson was a man whose mind embraced all manner of subjects with unusual clearness, and he was the foremost statesman and financier of his time.

It was his intention to establish an artificial means of transit across the American Isthmus, and he engrafted upon his scheme the brilliant idea of controlling this strait and forming here the grand distributing center for the commerce of the world.

In 1695 a company was formed under a charter from the Scotch Parliament acknowledged by the King of England and having its headquarters in Edinburgh.

In London, in nine days, subscriptions to the amount of £300,000 were taken, while in Hamburg, £2,000,000 worth of stock was subscribed for. When we remember the limited coinage of that day, these figures show the enthusiasm with which the new company was received.

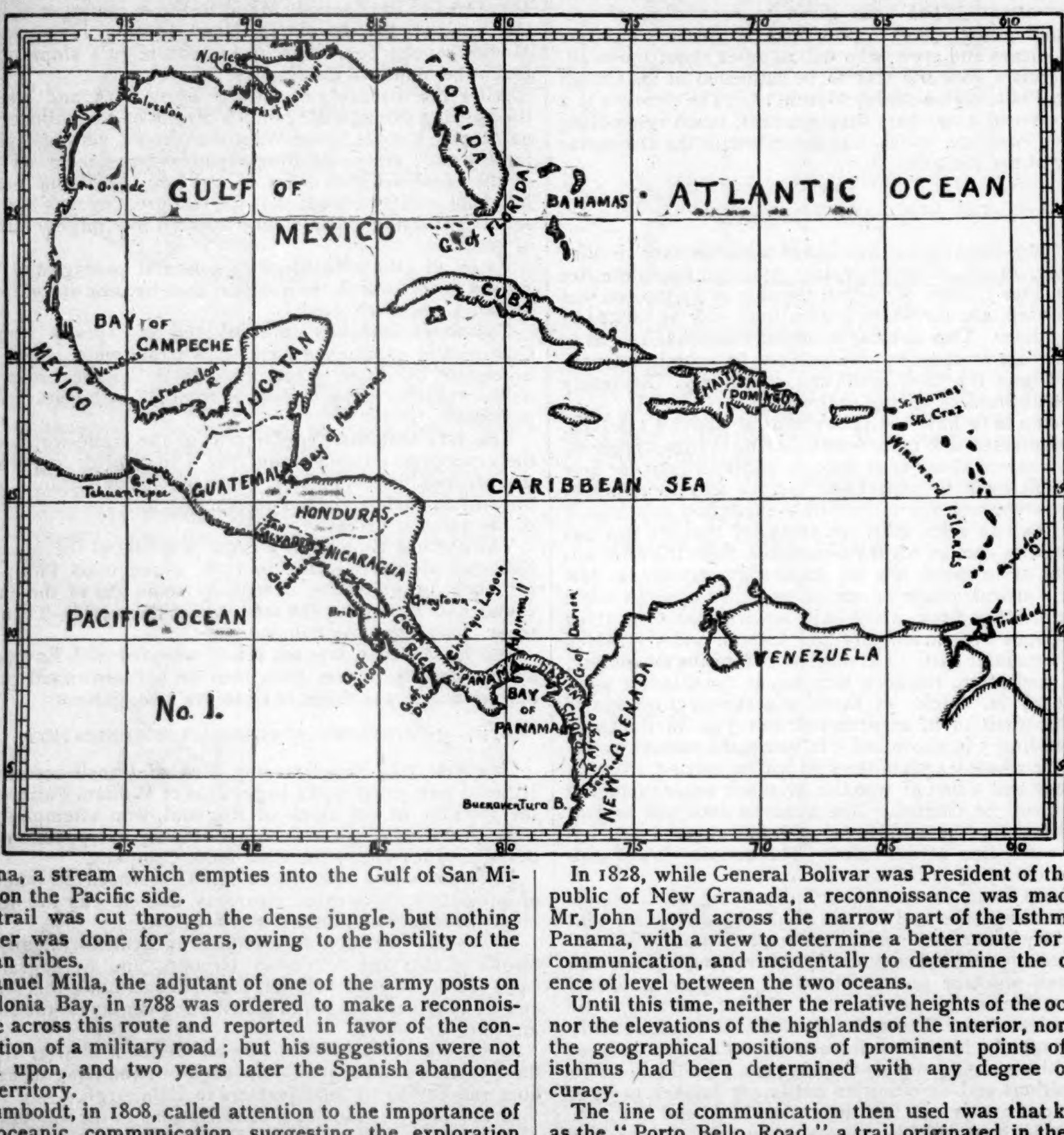
The first colonists left Scotland in July, 1698, and after a short voyage arrived at the Isthmus of Darien, founding a colony on a small peninsula jutting out into what is now known as Caledonia Bay.

The King of England, however, influenced by the East India Company, issued orders to the Governors of Jamaica and New York to withhold all supplies from the new colony, at the same time accusing the promoters of the colony of having treasonable designs.

Although harassed by disease and deserted by their own monarch, the hardy Scotch did not despair, and for some months continued their attempts at settlement of the country, but were finally driven to seek asylums among the other English colonies in the West Indies ; and thus ended the only Scotch attempt at colonization.

### III.—EARLY EXPLORATIONS.

After the departure of the Scotch colonists, the Spanish assumed control of Darien and the neighboring territory, and for some years attempted to obtain supremacy over the Indians, and to open regular transit by establishing a line of army posts extending between Caledonia Bay and Puerto Principio, an early Spanish settlement on the Rio Savana, a stream which empties into the Gulf of San Miguel on the Pacific side.




A trail was cut through the dense jungle, but nothing further was done for years, owing to the hostility of the Indian tribes.

Manuel Milla, the adjutant of one of the army posts on Caledonia Bay, in 1788 was ordered to make a reconnoissance across this route and reported in favor of the construction of a military road ; but his suggestions were not acted upon, and two years later the Spanish abandoned this territory.

Humboldt, in 1808, called attention to the importance of interoceanic communication, suggesting the exploration of the several most probable routes ; expressing his belief that a route either across the Isthmus of Darien, or by way of the Atrato River, would be the most practicable.

After the Spanish-American States had achieved their independence numerous explorations were made, chiefly with a view to internal improvement of the several States, but all productive of increased knowledge of the country.

In 1825, Señor Cañaz, at that time Minister from the Republic of the Center of America, addressed a letter to Mr. Clay, then Secretary of State, calling the attention of the United States to the importance of uniting the Atlantic and Pacific oceans, and desiring the co-operation of the United States, intimating that in event of a canal being built, its possession would be guaranteed to the two republics.

Both the President (Mr. Adams) and Mr. Clay thought favorably of this, and Mr. Williams, a newly-appointed Chargé d'Affaires, was instructed to examine carefully the facilities that Nicaragua offered for such a water-way, after which it was intended to lay the subject before Congress. Mr. Williams, however, seems not to have forwarded any information on the subject.

In 1825, there was a Governmental survey made across the Isthmus of Tehuantepec, which resulted in a brief but definite report, showing the impracticability of constructing a canal in this locality, owing to the high mountain ranges to be overcome and the poor harbor facilities at each terminus.

In 1828, while General Bolivar was President of the Republic of New Granada, a reconnoissance was made by Mr. John Lloyd across the narrow part of the Isthmus of Panama, with a view to determine a better route for land communication, and incidentally to determine the difference of level between the two oceans.

Until this time, neither the relative heights of the oceans, nor the elevations of the highlands of the interior, nor even the geographical positions of prominent points of this isthmus had been determined with any degree of accuracy.

The line of communication then used was that known as the "Porto Bello Road," a trail originated in the time of Cortez. Lloyd's report recommended that there be substituted for this a new route, starting from Limon Bay (Navy Bay) on the Atlantic side, which is substantially the line of the present Panama Railroad.

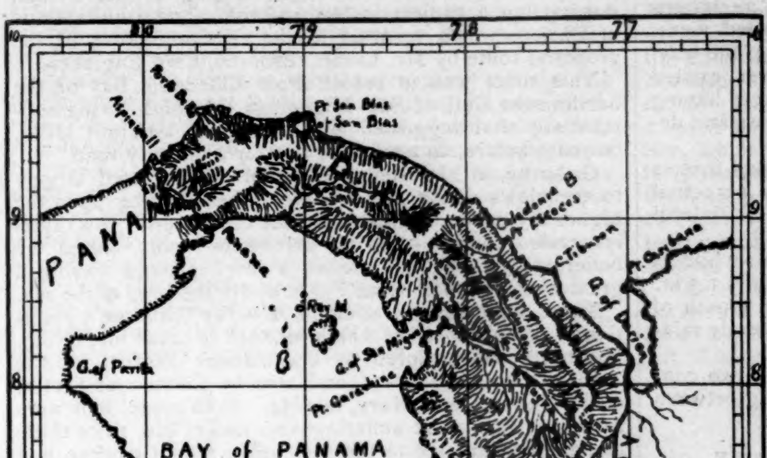
This survey also demonstrated that the mean height of the two oceans was almost the same ; until this time a contrary opinion had existed with regard to this.

Numerous projects were entertained from time to time,

but not until after 1849 was public attention again drawn to this subject.

In the development of the western portion of the United States lies the power which has, in the last 40 years, rendered it imperative that our Government should take action upon this matter. Our acquisition of California and the Northwest Territory, the discovery of gold and the rapid increase in the population of the western coast of North and South America, demanded that all nations should combine to seek a practical solution of this problem.

The construction of the Panama Railroad, commenced in 1850, taught us much with regard to the general characteristics of that isthmus, while the through transit of goods and passengers emphasized the importance of an uninterrupted water-way.




The erroneous opinion that the Rocky Mountains and the Andes extended in unbroken continuity, was exploded, and it became well known that the greatest elevation to be crossed in passing from ocean to ocean, was, in dozens of places, only 800 ft. above sea-level.

## IV.—CONTRAST BETWEEN THE AMERICAN AND THE EGYPTIAN ISTHMUSES.

It will be well here to examine the characteristics of this series of connecting isthmuses in order to more fully discuss the various routes that have from time to time been proposed.

Much surprise is manifested by those only generally informed on the subject, that the Isthmus of Panama remains a barrier to the same corps of engineers who so successfully completed the Suez Canal.

The Isthmus of Suez—some 120 miles in width—consists of a sandy depression, whose greatest elevation is only 50 ft. above the level of the sea.

Between the low sand-hills in this undulating tract of land, salt-water lakes occupied the lowest levels, and the work of piercing the Isthmus of Suez consisted in removing the sand from these dunes, and permitting the waters from the Mediterranean and the Red seas to fill the intervening hollows.

A glance at the map of Mexico and Central America shows the marked contrast between the American isthmus and that of Egypt. While the latter is a low-lying strip of sand separating two oceans, the former is a series of rugged mountain chains connecting two continents.

From the Coatzacoalcos River in Tehuantepec, where the continent of North America really begins to expand, to the Gulf of Darien, where South America may be said to commence, is one continued isthmus of some 1,250 miles in length, varying in width, owing to the indentations of the coast-line, but ever presenting a rugged, mountainous barrier.

This connecting strip consists of a series of isthmuses, all of which, with the exception of Nicaragua, have generally the same characteristics. They have a high "divide," which is generally found very near to one of the coasts. Near the sea-coast of that side having the most gradual slope are found low-lying alluvial deposits, forming lagoons, while there is a scarcity of good harbors on either side.

The rainfall of this tropical belt is an obstacle to be considered, while there exists an ever-present danger from earthquakes, naturally frequent in this section, which contains, in proportion to its size, more active volcanoes than any other part of the globe.

These volcanoes are all on the Pacific slope, and the Eastern slope, though in many cases consisting of broken mountain ranges, shows few traces of recent volcanic action. In the Nicaragua region the volcanic action has apparently exhausted itself, while throughout the whole of Central America, the earthquakes are not now of sufficient force to interfere seriously with a canal. The earthquakes occur most frequently at the time of the change of the tropic seasons —wet and dry.

The greater part of the isthmus lies in the neutral belt, between the northeast and the southeast trade-winds, a region of excessive rainfall, and having two distinct rainy seasons, during which the humid atmosphere causes malarious fevers, while at the same time stimulating excessive tropical growth of vegetation.

The trade-winds, born of the sun's warmth, follow it in its declination, the whole trade-wind system traveling a certain distance north, and then returning south, each year.

The Zone of Calms is from 5° to 7° in width, and travels through 16° or 18°, coming to 12° north latitude in the summer, and retreating to 5° south in the winter. All places in this belt are influenced by this trade-wind movement, and there are thus two well-defined rainy seasons experienced near the middle of the zone, while the edges have but one a year.

The Isthmus of Darien, and as far northward as 6° north latitude, experiences two rainy and two dry seasons each year, divided about as follows: From January to March, inclusive, is a dry season; from April to June, inclusive,

is a wet season ; July, August, and September, dry ; October, November, and December, a wet season.

The dry seasons, however, are not free from rain, but only so by comparison with the down-pouring rainfall of the wet seasons. The dry seasons are rendered pleasant by the trade-winds which at that time prevail ; but in the wet seasons the calm, humid atmosphere is enervating in the extreme.

Heavy continuous rains have washed away the clayey mountain-sides, which, however, still give support to the trees, till now the protecting covering of leaves and roots serves as a shield to prevent further wash, while the rank vegetation finds foot-hold in the crevices of the disintegrating rock. The sharp, serrated profiles of the mountains alternate with low-lying jungles of thickly-matted vines, through which the explorer must cut each foot of the way.

In Darien, and in the valley of the Atrato River, existed hostile Indian tribes, who, in their ignorant fear of having their homes invaded, did all they could to harass and destroy the reconnoitring parties.

Hundreds of venomous reptiles and poisonous insects infest this tropical region, secure beneath its perpetual foliage until they have inflicted the deadly bite or painful sting.

The annual rainfall at Aspinwall is 124.25 in., while at Cairo, in Egypt, the mean annual rainfall is only 1.3 in. The total rainfall noted at Aspinwall for the month of November, 1870, was 32.5 in., or 25 times the yearly rainfall on the Isthmus of Suez.

There could not be a greater contrast between two connecting strips of land than the difference existing between the American isthmus and the isthmus of Egypt.

### V.—THE EXPLORATIONS MADE BY MR. KELLEY.

To make explorations through unhealthy dense forests inhabited by hostile savages, required such expensive outfits that few private explorations were attempted, and these productive of but little additional information ; yet the first expedition of importance was, nevertheless, undertaken by a private individual, Mr. F. M. Kelley, a wealthy citizen of New York, who, purely in the cause of science, interested himself and his fortune in the attempt to discover some feasible line for a ship canal.

Humboldt had cited either Darien or the valley of the Atrato, as the most favorable region, and Mr. Kelley determined to investigate these localities.

He engaged the services of the eminent engineer J. C. Trautwine, who in 1852 made an exploration to prove or disprove an existing legend that a small canal had been constructed and used by natives to transport canoes from the head-waters of the Atlantic to those of the Pacific streams.

The legend called this the Raspadura Canal, and located it as connecting the head-waters of the Atrato and the San Juan rivers. The Atrato is a large stream taking its rise in the mountains in about 5° north latitude, and, flowing northward, empties into the Gulf of Darien. The San Juan is a smaller stream, which takes its rise near the same place, and flowing southwesterly empties into the Pacific, just north of Buenaventura Bay.

Trautwine's survey disproved this legend, and his report was adverse to any attempt at water communication by this route. Notwithstanding this unfavorable report, Mr. Kelley was not disheartened, and in 1853 he organized two additional exploring parties—one under the command of a Mr. Porter and the other commanded by Mr. Lane, but their results only confirmed Trautwine's report.

Mr. Kelley, determined not to be baffled, then began the search for a route by way of the Truando, one of the western tributaries of the Atrato. This route was explored by Lane and Kennish, under the supervision of Mr. Kelley, the only success attending their work being that Kennish clearly established the fact that the two oceans had the same mean level.

Although failing in his undertaking, yet the earnest work of Mr. Kelley had the effect of causing the Government of the United States to become interested in the affair to that extent that an official expedition, with the consent of the Government of New Granada, surveyed a route by way of the Truando River in 1857. This, however, still further demonstrated the hopelessness of constructing a canal in this region, owing to the numerous ranges of mountains.

The strong political feeling which prevailed for the next few years, and which culminated in the breaking out of the Civil War, prevented further action being taken by the United States Government.

### VI.—DR. EDWARD CULLEN'S ROUTE.

In 1850, Dr. Edward Cullen, of Dublin, Member of the Royal Geographical Society of Great Britain, having secured a concession from the Government of New Granada, presented before the Edinburgh meeting of the British Association a project for a ship-canal across the Isthmus of Darien, which resulted in the reconnoissance of the proposed route by Mr. Lionel Gisborne, Civil Engineer.

This route was to extend from Caledonia Bay on the north to the Gulf of San Miguel on the south, being substantially that suggested by the Spanish adjutant Milla, 60 years before, as a suitable line for a military road.

Gisborne, in his attempted exploration, trusted largely to the views which met his eye when standing upon the higher divides—a source of almost certain error in a thickly-wooded country—and his erroneous report caused the belief that there here existed a level plateau having a greatest elevation of some 150 ft. above the level of the sea.

There were several attempts to verify Gisborne's assertion to this effect, all of which resulted in much loss of life. His route was explored by Commander Prevost, of the British Navy, in 1853–54, and also by Lieutenant Strain, of the United States Navy, in 1854. Both expeditions were attended with great suffering and loss of life, since these commanders trusted to the statements that Gisborne had made.

Prevost started from the Pacific side, and attempted to cross to Caledonia Bay by the route which was supposed to lead to that point ; but owing to the poor geographical knowledge possessed at that time, his course was directed too far to the northward, and he finally returned, to find that some of his men, who had been following in the rear, had been massacred by the Indians.

The story of Strain's expedition across the Isthmus is well known. It is a repetition of the record of daring, courage, and fortitude under suffering, that characterizes the Anglo-Saxon race. It is unnecessary to do more than briefly allude to it in this article.

### VII.—STRAIN'S EXPEDITION.

Led by the report of Mr. Gisborne to believe that this plateau existed a few miles inland at this point, Strain, attended by a party of volunteers, left the United States ship *Cyane*, anchored in Caledonia Bay, and attempted to trace a line of transit from this bay to strike the Savana, one of the rivers flowing into the Gulf of San Miguel. It was known that the *Virago*, a British vessel of war, was anchored in the Gulf of San Miguel, and that she would furnish all possible assistance to the exploring party when it should reach the Pacific coast, and therefore only a limited supply of provisions was carried.

The explorers were successful in securing Indian guides from the tribes of the interior, and on January 21 started inland, following along the tortuous and almost indiscernible trails cut by their Indian guides.

Strain almost immediately found his way obstructed by mountain ranges from 1,000 ft. to 3,000 ft. in height, where Gisborne had declared over his professional signature that he had found an elevation of only 150 ft.

Strain, therefore, kept away to the northward along the mountain chain, in the hope of finding this pass. Continually seeking this plateau, and meeting only mountain chains, the party proceeded farther and farther inland ; their scanty stock of provisions became exhausted, and they found but small means of procuring food from the frightened natives, who, deserting their homes, took all sustenance with them, so that our explorers found only desolate huts. But imbued with the idea that they must soon reach this pass, they pressed onward, finally following to the southwest the course of a stream of considerable size, which we now know as the Chucunaqua River, only to meet disappointment at each succeeding turn.

Deserted by their treacherous Indian guides, who had purposely misled them, and weak and exhausted from insufficient food, the little band on February 13 separated; Strain hurrying forward, with three of the hardier members of the party, to obtain assistance, while the remainder, under Passed Midshipman (late Commodore) Truxtun, after following for some days down the Chucunaqua, and concluding that Strain and his companions had been murdered, retraced their steps and attempted to regain the *Cyane* on the Atlantic side.

Strain, exercising all haste, managed on March 9 to reach Yavisa, a small settlement on the Chucunaqua, and in communication with the Gulf of San Miguel, and immediately returned with food and assistance furnished by the *Virago*, the sturdy Britons rowing night and day; yet he did not overtake Truxtun's party until it had gotten halfway back to Caledonia Bay.

The party was over two months struggling through this jungle, some days not making more than one mile in advance. Several died of starvation, and all suffered terribly from the effects of the journey, two members dying after their rescue. During this entire time perfect discipline was maintained, and the record of the expedition is filled with deeds of heroism and unselfishness.

The results of the expeditions under Strain and Prevost did not yet cause the abandonment of this route as a possible line. Dr. Cullen succeeded in interesting in this project M. Roger, of Paris, who founded the Société d'Études, under the direction of which society M. Bourdiol, a prominent engineer, attempted a resurvey of this line, to meet, however, with disappointment, owing to the desertion of his negro workmen upon nearing the interior, through fear of the Indian tribes.

Nevertheless, the enthusiastic Bourdiol felt competent to make estimates for a canal, and did so, designing a canal 31 miles in length to overpass an elevation of 144 ft., and to be furnished with 22 locks, 11 on each side. The cost of this visionary canal was to be $34,000,000.

Mr. Gisborne subsequently made a more careful exploration of this route, which resulted in the determination of the *lowest* divide with an elevation of 930 ft.!

NOTE BY THE AUTHOR.

In the compilation of this article and of those which will follow it, I have been allowed by the Navy Department to use all data connected with the subject.

I have taken the liberty of reproducing much of the information contained in the report of Lieutenant J. T. Sullivan, U.S.N., prepared by direction of the Secretary of the Navy, and printed in 1883. The early history of the explorations, as well as the short account of Strain's expedition, have been mainly taken from Lieutenant Sullivan's report.

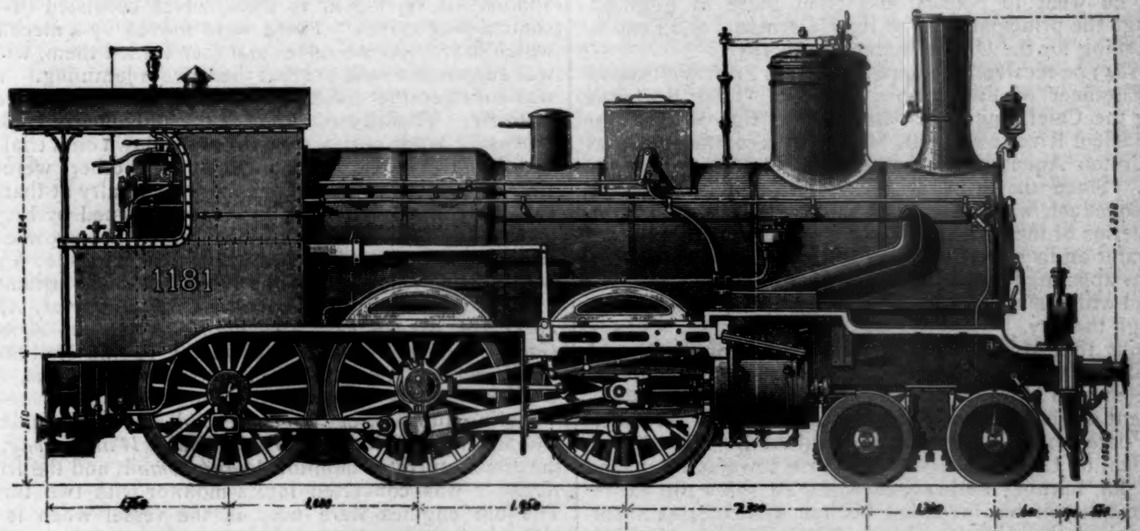
I have also made use of the Report of Commander Thomas O. Selfridge, U.S.N., printed in 1874, and that of Civil Engineer A. G. Menocal, U.S.N., published in 1885. I desire to return my thanks to the President of the Nicaragua Canal Company, as well as to Commander H. C. Taylor, U.S.N., for the latest data with regard to the Nicaragua Canal.

(TO BE CONTINUED.)

## AN ITALIAN TEN-WHEEL LOCOMOTIVE.

THE accompanying illustration, from the London *Engineer*, shows a locomotive with six drivers coupled and a four-wheel truck, designed for the Italian Mediterranean Railroad by Commendatore Frescot, Chief Engineer of Motive Power of that road. It was specially intended for working the through passenger and fast freight trains on the Company's line between Genoa and Alessandria, which has some heavy grades on the section crossing the Appenines. The through passenger trains are required to make a speed of 50 km., or about 31 miles, an hour, on this section, which includes one grade about 14 miles long of 91 ft. to the mile, with several curves of 984 ft. radius. The first engine of this type was built at the Company's shops at Turin, and proved so successful that 40 more have been built with but slight modifications from the original locomotive.

The boilers of these engines are 60 in. in diameter of barrel and 18 ft. 6 in. in length over all. They have 203 tubes $2\frac{1}{16}$ in. in diameter and 15 ft. long. The fire-box is 7 ft. 8 in. in length and 3 ft. 3 in. in width. It is on the




TEN-WHEEL LOCOMOTIVE, MEDITERRANEAN RAILROAD OF ITALY.

Belpaire system, the flat crown-sheet being connected to the outside shell by wrought-iron stays. The fire-box is of copper and the tubes of brass. The grate area is 24 sq. ft., the fire-box heating surface 114 sq. ft., and the heating surface of the tubes 1,600 sq. ft. The grate is inclined. The usual working pressure carried is 150 lbs.

The cylinders of these engines are $18\frac{1}{2}$ in. in diameter and $24\frac{1}{2}$ in. stroke. The slide valves are on top of the cylinders, and the valve-motion is all outside. Gooch's valve gear is used, with screw reversing gear. The piston-rods, cross-heads, and connecting-rods are all of steel, and metallic packing is used in the stuffing-boxes. The piston-rods are screwed into the iron pistons.

The driving-wheels are 5 ft. 6 in. in diameter, and the total rigid wheel-base is 13 ft. The four-wheel truck has wheels 33 in. in diameter, placed much closer together than is usual in our practice, the cylinders being, as shown, entirely back of the truck. The total wheel-base of the engine is 24 ft. The axles and tires are of steel, and both driving-wheels and truck-wheels are of wrought iron.

As is usual in European practice, the frames are of the plate type, the plates being $1\frac{1}{8}$ in. thick. They are braced together by several cross-stays, two of which, under the smoke-box, carry the bearings for the truck.

The engine has a blast nozzle, with a valve for increasing

or diminishing the area of the opening. It is provided with the Westinghouse air-brake and with driver-brakes. There are two Friedman injectors for supplying the boiler. The cab is of sheet-iron, and the dome is placed on the forward end of the boiler.

The chief peculiarities of the engine to our eyes will be the position of the valve gear outside and the carrying of the cylinders back of the truck. This seems to be a somewhat awkward arrangement, requiring a long steam-pipe, with a considerable portion outside of the boiler.

The tender is carried on six wheels of 44 in. diameter, with inside axle-boxes, and has a capacity of 2,200 galls. of water and 3½ tons of coal. Its total weight is 15 tons empty and 28½ tons loaded.

## HORATIO ALLEN.

(*Concluded from page 117.*)

IN 1834, after the South Carolina Railroad was finished, Mr. Allen married Miss Mary Moncrief Simons, daughter of the Rev. James Dewar Simons, of Charleston. He remained in Charleston until 1835, and in the spring of that year he went abroad, accompanied by Mrs. Allen, and devoted nearly three years to foreign travel, returning to America near the close of 1837. During that time he made the entire passage of the Danube to the Black Sea and Constantinople, went thence to Smyrna, the Asiatic Coast, to Athens, and across the Levant to Alexandria, and spent the winter on the Nile; returning in the spring of 1837, he went to Naples, and from there to England, through the principal cities of Italy, Germany, and France, embarking for the United States late in 1837.

In 1843 he received the appointment of Principal Assistant Engineer of the Croton Aqueduct, John B. Jervis being the Chief Engineer. Before the High Bridge over the Harlem River was built, Mr. Allen recommended that the Croton Aqueduct be carried in a tunnel below the river. Since then this plan has been adopted for the new aqueduct, which now passes under the river. On the completion of the Croton Aqueduct, in 1844, he first turned the water on to supply the city of New York. Afterward he was appointed one of five commissioners who were intrusted with the supervision of the distribution of the water through the city.

About 1844 Mr. Allen became a member of the firm of Stillman, Stratton & Allen, who were the proprietors of the celebrated Novelty Works in New York. This establishment originated in a somewhat curious way. Previous to the date when this firm was organized Dr. Knott, then President of Union College, invented a stove and a steam boiler for burning anthracite coal. To show the entire practicability of his invention he had a small steamboat built called the *Novelty*, which ran from New York to Harlem. At night this boat was laid up at a landing at the foot of Twelfth Street. A small shed was then erected there, with a few tools for doing repairs on the boat. This shop was extended, and it came to be known as "The Novelty's Works." This shop passed into the hands of Mr. Stillman, who extended it and did various kinds of machine work there. After Mr. Allen entered the firm the business, grew very rapidly in various directions, and included mill-work of various kinds, stationary and marine engines, pumps, sugar machinery, steam fire-engines, hydraulic presses, etc.

The firm of Stillman, Allen & Company was formed in 1847, and consisted of Thomas B. Stillman, Horatio Allen, Robert M. Stratton, George F. Allen, and William B. Brown. The Novelty Works finally became the largest establishment in the country for building marine engines. The machinery for many of the old Collins Line of steamers and the Pacific Mail Steamship Company, was built there, including the engines of such ships as the *Pacific*, *Atlantic*, *Adriatic*, *Arctic*, and *Baltic*. All these had side-lever engines excepting the *Adriatic*, which had oscillating engines, with two cylinders 9 or 10 ft. diameter and 13 ft. stroke.

Mr. Allen was always a great advocate of oscillating cylinder engines for side-wheel steamships, and in 1867 he wrote what he called "a statement of facts and considerations in reference to beam and oscillating engines for marine side-wheel steamships," which was addressed to Allan McLane, President of the Pacific Mail Steamship Company, and was afterward published in a pamphlet. In this Mr. Allen compared engines with 85-in. cylinders and 8 ft. stroke, and claimed that the room occupied by the oscillating engine compared with the beam engine is 8,500 cubic feet for the one and 14,750 for the other; the weight 138 and 152 tons respectively; the number of parts through which the power is transmitted from the piston to the crank is three for the oscillating engine and nine for the beam engine; the number of parts which must be constructed in true line and relation to each other is three for the oscillating and six for the beam engine; the number of bearings and their brasses to be kept in proper adjustment and lubrication is five for the oscillating and 13 for the beam engine. He also explained that the structure through which the power was transmitted from the cylinder to the crank-pin would be much stronger and more substantial, and the strain on the bottom of the vessel less with the oscillating than with the beam engine; the weight, which comes to a state of rest in passing the centers is 6¼ tons in the one engine and 30 in the other; the valve-gear of the oscillating engine, it was admitted, has more parts than that of the beam engine. It was also claimed that all the journals of the oscillator are as accessible as those of the beam engine, that the first could be balanced by cast-iron buckets on the wheel as perfectly as the latter is by the weights at each end of the beam.

The *Adriatic* had oscillating engines, and Mr. Allen applied his valve-gear to them, which consisted of large conical plug-valves. These were moved by a mechanism which first lifted the valves and then turned them, which it was supposed would prevent them from jamming. There was considerable difficulty in getting them to work satisfactorily. This caused much delay and involved a heavy expense. Some part of the gear broke down on a trial trip, and the valves were finally taken out and others were substituted for them. As there was great rivalry at that time between the Cunard Line—which was owned by Englishmen—and the Collins steamers, which were owned by Americans, this experimental valve-gear attracted a great deal of attention, and was the subject of much criticism.

The engines for the *Constitution*, *Moses Taylor*, *Ancon*, *Mariposa*, *Great Republic*, *Idaho*, *Montana*, *Arizona*, *Golden Age*, and *Golden Gate* for the Pacific Mail Steamship Company were all built at the Novelty Works. The *Golden Gate* also had oscillating engines.

During the War engines were built for three gun-boats and also for the sloops *Adirondack* and *Wampanoag*, and the double-turreted monitor *Miantonomah*, and the frigate *Roanoke* was converted into a monitor with two turrets. The old engines were used in the vessel when it was altered.

At one time there were over 1,500 men employed in the Novelty Works, but so great was the difficulty of getting men at that time, that Mr. Allen went to Europe and employed a large number there who were brought over.

It was during the War that the somewhat acrimonious dispute, with reference to the economy of using steam expansively arose. On the one side were those, including Mr. Isherwood, the Chief of the Bureau of Steam Engineering, who advocated the use of comparatively low pressure and moderate degrees of expansion in the engines then in use; and on the other side was the late Mr. E. N. Dickerson and others, who claimed that greater pressures and excessively high degrees of expansion were the most economical. The subject was discussed on both sides with great fierceness and attracted the attention of Congress, and finally the Naval Committee requested the Naval Department to have a series of experiments made "to assist in determining the limitation of the economical expansion of steam under practical conditions, and other collateral questions relating to the general subject." *

The experiments were to be made under the supervision of a Committee of the Franklin Institute of Philadelphia, and the Smithsonian Institute of Washington, and three

* Paper on the Cost of Power in Non-Condensing Steam Engines. Read by Charles E. Emery before the American Society of Mechanical Engineers, 1888.

civilian engineers, of whom Mr. Allen, who believed in high rate of expansion, was one. If Committees were appointed by the Institutions named, they did not take an active part in conducting the experiments. These were made during the years 1864 to 1868 at the Novelty Works, under the general direction of Mr. Allen, who was then the President of the Company, and Chief Engineer Isherwood, at that time the Chief of the Bureau of Steam Engineering, U.S.N., who detailed a corps of assistants to do the work.

The experiments were commenced at the Novelty Works on a large scale. Engines with various-sized cylinders were constructed. These were connected with a large air fan, the revolutions of which represented the work done. Much time and money was consumed in getting this machinery to work satisfactorily, and in making the experiments, and apparently they did not prove exactly what either side anticipated. While they were insufficient to settle all the points at issue they showed what is well known now, that the point of cut-off which is most economical becomes shorter as the pressure is increased, but that with any pressure, the most economical degree of expansion is soon reached and the cost rises rapidly after this point is passed.

So much time was consumed in making the experiments that some of those who formed the Commission lost interest and practically abandoned them, possibly because the results did not prove what it was expected they would. The work was then carried on by Chief Engineer Isherwood and his assistants in consultation with Mr. Allen. The cost of the experiments went up to over $100,000, and as the time consumed was so great and the results were apparently inconclusive, the Navy Department finally ordered them discontinued. The Commission in charge of them never made a report nor were the results published under Government authority, although a general table was furnished by Mr. Isherwood to Mr. R. H. Buel, who had it published in the articles on Steam Engineering which he prepared for Appleton's Cyclopædia of Mechanics and in the American edition of Wiesbach's Mechanics.

It is not easy now to learn what was the precise significance, or rather what was proved by these experiments. Apparently they did not show as great an economy from the use of high-pressure steam and high rates of expansion as the advocates of that side of the question expected, though the results with high-pressure steam showed greater economy than those with low pressure, and it was also found that it was economical to cut off shorter with high than with low-pressure steam. The experiments were, of course, made with engines of the kind then in most general use, and did not include compound or triple-expansion engines with the very high pressures which have been made practicable by their use. It is evident now that those who then advocated the use of high-pressure steam and excessively high degrees of expansion, did not understand fully how steam used under these conditions is affected by various circumstances, especially those existing when steam is expanded in a single-cylinder engine.

Afterward, a competitive trial was made by Commodore Isherwood and Mr. Dickerson with two United States vessels, the *Winooski* and the *Algonquin*. They were first tied up in a dock and their wheels were turned at a regular rate and a careful record was kept of the fuel consumed. In these trials the *Winooski*, Commodore Isherwood's vessel, had an engine with double poppet-valves and Stevens cut-off. The *Algonquin* had a Sickles cut-off with single poppet-valves.

Trials of speed were afterward made at sea. The *Winooski* then used steam of 25 lbs. pressure cut-off at $\frac{8}{10}$ of the stroke, and the *Algonquin* carried 90 lbs. of steam and cut-off at $\frac{1}{10}$.

The failure of the *Algonquin* in these trials is now a matter of history.

After the experiments at the Novelty Works were ended, Mr. Charles E. Emery, who was an assistant engineer in making them, suggested a supplementary series with a small engine having 8 × 8 in. cylinders. The officers of the Novelty Works agreed to bear the expense of these which amounted to about $5,000. The results of these experiments with non-condensing engines were afterward published by Mr. Emery in the proceedings of the American Society of Mechanical Engineers in 1886 and 1888.

While the investigations were being made, it is said that Mr. Allen suspended judgment thereon, as was proper he should. Those who were intimately associated with him at the time never heard him express an opinion with reference to the subject after the experiments were ended.

In the light of our present knowledge it seems singular that experiments on such a scale were needed to show what now seems so easily proved. Doubtless some of the experiments of the present day will appear equally needless 25 or 30 years hence.

During all of Mr. Allen's career he was a prolific inventor, as will appear from the following list of patents which he took out:

| | | |
|---|---|---|
| Steam Cut-Off | H. Allen | 1841 |
| Stop Cock | " | 1841 |
| Steam Cut-Off | " | 1842 |
| Determining Thickness of Metal Pipes. | H. Allen | 1843 |
| Tapping Mains. | H. Allen | 1843 |
| Steam Cut-Off | " | 1847 |
| Steam Cut-Off | " | 1849 |
| " " " | " | 1849 |
| Steam Engine Valve-Gear, | Allen & Wells | 1853 |
| " " " " | " " | 1853 |
| " " " " | H. Allen | 1857 |
| Steam Boiler Tube Joint | " | 1858 |
| Car Seats and Couches | | 1866 |
| Connecting the Tubes with the Heads of Surface Condensers. | H. Allen | 1868 |
| Sleeping Cars | | 1876 |
| Terrestrial Globes | | 1879 |

The Allen & Wells cut-off, in its several different forms, was introduced to some extent, and is still in use on different steamboats. The method of connecting condenser tubes to their heads, with compressed wooden ferules, has also been extensively adopted.

During the War, although a great deal of work had been done at the Novelty Works, the success of the Company was not proportionate to the amount of the business. They were operated during part of that period under the disadvantage of a market in which the prices of labor and materials were constantly rising. Contracts were taken at fixed sums, and it was then not easy to anticipate what the increase would be in the cost of doing work before it was finished.

When the War was ended there was, of course, a cessation of Government work. Business at the Novelty Works had been conducted on a large scale, with fixed expenses in the same proportion. The tools and machinery were old and out of date, and it was soon found that the Works were being conducted at a loss. To remodel and re-equip them with new tools and machinery to meet the changed condition of business, would involve a large outlay of capital. The real estate was very valuable, and it was finally determined to close the Works and wind up the business. This was done in 1870 and the Novelty Works soon ceased to exist. The business which was conducted then, like most great enterprises, was attended with varying success. Under the firm of Stillman, Allen & Company it was at first very profitable, but some heavy losses embarrassed the firm and they had to seek outside aid. Mr. James Brown furnished the firm with more capital, and when a stock company was organized he became a stockholder. During the War the business was very active and during part of the time profitable, but Mr. Allen was then not a large holder of the stock.

During his connection with the Novelty Works he also acted in the capacity of Consulting Engineer for the Erie Railroad. He was also Consulting Engineer to the Panama Railroad Company for a short time, and during that period also held incidentally other important engineering trusts. His professional career may be said to have ended as Consulting Engineer of the Brooklyn Bridge.

In 1870 Mr. Allen retired from active life and built himself a house in a retired spot near Mountain Station, on the Morris & Essex Railroad in New Jersey, where he resided up to the end of his life. He left a widow, three daughters, and a son. He always seemed to derive his chief enjoyment in life from his delightful home, but this was especially the case during the latter years of his life.

He was a man of very quiet domestic tastes, but took a lively interest in engineering, scientific, and especially educational matters, up to the last.

He was brought up an Episcopalian, but in early life became one of the prominent members of All Souls' Unitarian Church, under the charge of the Rev. Dr. Bellows, and always took an active interest in philanthropic and charitable matters. He was one of the founders of the Union League Club, and an active member of it in the days when its influence was exerted in behalf of great national questions, and before narrow partisanship had contracted its sphere of usefulness. He was also one of the organizers, and for a long time an active member, of the Association for the Improvement of the Condition of the Poor, the Children's Aid Society, and the New York Gallery of Art, which was instrumental in preserving what was known as the Abbott Collection of Egyptian antiquities, which now forms a part of the New York Historical Society's collection.

Mr. Allen took an interest in a very wide range of subjects. During his later years he devoted much time to the subject of education, and was especially interested in the methods of teaching astronomy. He wrote a book on that subject and invented and constructed a number of instruments to facilitate the study of astronomy in schools. He also wrote an elementary book on arithmetic, with a view of simplifying the methods of teaching.

His life and experience, if it could be fully written, would be of exceeding interest.

In his later years he often expressed regret that he did not keep a record of the events of his early life, and especially his observations during the period that he first visited Europe. He was then on intimate terms with George Stephenson and the early fathers of the railroad system. He was in England to study that system, which was then, if not in its infancy, at any rate in its early youth. If his observations had been fully recorded, they would now be of intense interest. Beginning his study of engineering in early manhood, when railroads were an experiment, it extended over the period, so recently ended, which covered completely that wonderful era of modern development which has been due to the introduction, application, and diffusion of steam-power over the whole civilized world.

Among the marked traits of Mr. Allen's character were his gentleness and generosity, which it is said "is in nothing more seen than in a candid estimation of other men's virtues and good qualities." He was always ready to give a helping hand to those who were down and trying to get up. His words and acts of encouragement to many young men beginning the hazardous voyage of life, were like propitious breezes and inspired them with hope which sustained them until they reached port. A paper published near his home said of him: "His integrity was of the most unswerving, unflinching kind, and he was scrupulous almost to a fault over matters that ordinarily pass current in the mercantile world." The modern forms which business bribery has assumed excited in him unbounded indignation. A gentleman occupying a prominent position in public life, and who was associated with Mr. Allen during one of the most trying periods, said of him, he was "a true gentleman of the old school."

His last years were spent quietly with his family in his home near South Orange, in New Jersey. It may be said of him that his integrity commanded the respect of all honest men who knew him; his generosity made many persons his debtors, and the delight which he took in contributing to the happiness of others led all to be "kindly affectioned" to him.

## AN IMPROVISED ICE-HOUSE.

### SOME PRACTICAL WARM-WINTER ENGINEERING.

THE passing season has been an unprecedented one of its kind, as it was the second warm and open winter in succession, and it has caused a widespread demand throughout the Eastern States for harvesting ice off ponds, lakes, and rivers that usually are not used to any extent for that purpose. In consequence there has been great speculation in ice cutting and in the building of houses in which to store it. As some of our readers may be interested in this subject, we will give a brief account of the construction of these temporary ice-houses, and of the methods of stacking ice.

To better understand the enormous quantity of ice that is required to be harvested each year, we have only to remember that the cities of New York and Brooklyn alone consume about 3,000,000 tons of ice per annum. This represents a stack of ice about 844 ft. high, covering an area 800 × 200 ft., or the size of a large city block. In a favorable season, the ice companies supplying these cities try to house an extra million tons. Last winter being warm, no extra supply was secured, and when the present winter opened the companies found themselves without any supply to start with.

About the beginning of February, the companies began to cut ice from foreign fields, and the fever of speculation soon spread to outsiders. A few had already commenced, and these few will find themselves extremely fortunate.

The regular system of cutting ice is too well known to describe here, and the temporary methods adopted this winter were made to conform to them as nearly as practicable.

The first thing to do is to secure a suitable site for the house. A piece of level ground should be chosen, with an ice field in front of it in good condition. Select a place where the current of the water is as little as possible, so as not to wear away the ice when the first thaw sets in; where the water is deep near the bank for loading the boats in summer, or, if the ice is to be shipped in cars, near the railroad; and, again, a place sheltered from the winds, otherwise, after the ice has been opened the whole field is liable to move, crack, and pile up during a storm, thus ruining any chances for further operations.

If the site is a side-hill, the ice is apt to slip on melting, and if there is much movement to the stack, it will tear the house apart, as it is not constructed to withstand any such pressure. The next step is to determine how large a house is to be erected, and this is governed by the number of tons of ice required. A ton of stacked ice is reckoned as representing 45 cubic feet of space when properly stowed. Having decided on the size of the house, the lumber has to be purchased. For a temporary house, where there is little or no prospect of selling the old lumber, the cheapest kind of pine or spruce is to be preferred. The house is made rectangular in form. A mud-sill is first laid on the surface of the ground which has been smoothed of all inequalities. This mud-sill can be made of 2-in. stuff or of two 1-in. planks laid with broken joints. On this is erected a system of studs spaced about 2 ft. 6 in. in the clear. This will allow for the paper to be put on afterward.

These studs should be made of pieces 2 × 6 in. or 2 × 7 in. and 16 ft. long, which can be spliced so as to give any desired height to the house. These studs should be ceiled on the inside with planks laid horizontally, and this planking should be kept always higher than the pile of ice, so as to protect the edges from the wind and sun. Through the length of the building should be run a row of studs, spaced 5 ft. apart, dividing the house into rooms 25 ft. wide. This is for the purpose of supporting the roof, of which we will speak later. The ceiling or boarding can be made of 1-in. stuff, and the chief consideration to be observed is that it should be laid with as few cracks as possible, so as to keep the air from entering the house. Poles are sometimes used for studs, but they are not as good as squared stuff, since the planking cannot be put on so smoothly.

We now come to the inclines or slides. As the ice is usually plowed into cakes 32 in. long by 22 in. wide, a runway of 28 in. in the clear, allowing the cakes to go up lengthwise, will give very good results. These runways can be made as follows: For side pieces use 2 × 6 in. 8 ft. long. Thus 16 ft. stuff will cut into two pieces, with no waste. Set them up edgewise and fasten across the bottoms with ⅝-in. carriage-bolts, three strips 1¼ × 3 in. On these lay longitudinally and equally spaced strips 1 in. × 3 in., on which the cakes can slide. These slides are joined by pins and eyes, made by the blacksmith, and the whole supported by a trestle. The bents of this trestle can be made of 2 × 6 in. posts, spliced if necessary, and diago-

nally braced by 1 × 8 in. planks. This cross-bracing should be put in every bent, but if the ground is firm it is only necessary to longitudinally cross-brace every other bent. These bents should be spaced about 10 ft. apart and rest upon a plank for a mud-sill.

The grade depends largely on the site chosen, but the incline should be as short as convenient, care being used not to make it too steep. These inclines should be erected so as to connect with the ends of the house and not enter on the face, as it is much more convenient to raise the slides and to handle the ice in stowing. In turning a corner to enter the house, an iron band, 3 in. × ¼ in., is fastened to the outside piece of the slide and bent to conform to the arc required. On each side of the slide a pathway is made 2 ft. wide, with cleats nailed at convenient spaces, so that a man can easily walk up and down. The ice is hauled up these inclines by ropes operated by horses. The shore end of the rope has an ordinary hook spliced on, which will engage a ring on the whiffle-tree of the team, and can be easily hooked or unhooked by the driver. The rope then passes through blocks and down the slide. To the lower end is fastened a crab, which can be made of a piece of hard wood 3½ or 4 in. wide and 25 in. long, having three spikes or screws driven through it to catch the ice. A better crab is made out of a bar of iron bent so as to have two prongs that will hold the ice. A train of from 4 to 7 cakes of ice is pushed to the foot of the incline; this is about all one team can draw up the average incline, unless it is very short and the ice is very thin. The crab being placed so as to engage the last cake, the man standing on the top of the incline gives the signal to the team, and the ice is pulled up until the top of the slide is reached, whence the ice runs by gravity down a reverse incline, around a bend and into the house. One man comes up the incline with the ice and carries the crab back, walking on the pathway at the side. Two ropes are operated on one slide, and if there are no delays in the field they will require three teams. A slide such as this, with two ropes, three teams, and about 150 ft. long, will elevate from 200 to 300 tons per day of 10 hours' work, if the men are accustomed to it. An endless rope can be operated, but for temporary houses they generally give trouble, and the simplest devices, although, perhaps, not the most economical, prove the best in the end.

When the ice reaches the house it is stacked, as it is called, on the ground, and in even and regular layers, placing the length of the cakes one way on the first course, and at right angles in the next, so as to break joints and bind the mass together. A space from 2½ to 3 in. should always be left around the cakes, so that a bar can be passed between them to pry them loose in the summer.

As the ice pile increases in height, the carpenters must keep raising the boarding on the studding. No scaffolding is needed, as the ice forms a working platform itself. Sometimes the ice is packed with hay. In this case a space about 12 to 14 in. wide is left all around between the ice and the sides of the house, and hay is packed in this. On the outside of the boarding and between the studs paper sheathing is nailed on with lathes. The studs should be so spaced as to allow for a strip of paper to be put on between them, leaving about 1 in. to turn up on each side for a joint.

If the hay packing is good and the papering well done, it is not necessary to put on any outside boarding, although it would greatly improve the house. A better and more permanent method is to leave an air space of about 3 in. between the ice and the inside boarding. This boarding is put on the same as before and papered. Then paper is laid in horizontal strips across the house, and tacked to the outside of the studs, and over this again a second boarding is put on. This arrangement makes the house very tight, and allows two distinct air spaces. If the paper is put on the inside of the inner boarding, it is too apt to become torn, as it must be put on while the men are working.

As the walls of the house are built up, it is well to put ties across made of 1 × 8 in. stuff nailed to the outside studs and also to the central row or rows of roofing studs. These ties being set up edgewise can pass between the cakes of ice. The advantage of having the house divided into rooms, is that one room can be filled at a time, and in case of a thaw or breaking up of the ice field, the ice already cut is stacked in a compact pile and not spread out over a large area of little depth. It is best, but not necessary, to board up between every two rooms, as this makes it better during the summer, when the ice is being removed, as only one compartment is disturbed at a time. On top of the ice a layer of hay should be placed to a depth of 12 to 18 in. Straw should not be used, as it is liable to stain the ice.

The walls of the house should be carried up 3 ft. above the top of the ice. As the rooms are 25 ft. wide, 2 in. × 6 in. stuff, 16 ft. long, will make very good rafters and allow sufficient pitch. The roof is boarded, but the top ends of the gables are left open for ventilation. Between the gables a gutter is made by laying a strip of tarred sheathing paper, and painting with a coating of melted pitch. If for roofing lumber cheap material has been bought, so that the joints cannot be made tight, it can be papered with the same sheathing as the sides.

It will not be necessary to describe the ice field or the methods of working, but there is one point not often understood. In laying out the field, it is always advisable, other things being equal, to work from the outside toward the house, as this will always leave an undisturbed stretch of ice from the bank out to the working cutting, for the passage of the men and horses, and the canal has also firm ice on each side for the men to walk back and forth in towing the ice to the foot of the slides.

Ice stacked in such a temporary house will suffer from shrinkage, varying with the workmanship, from 15 to 40 per cent., but such a house answers very well the purposes for which it is designed.

## CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

### CHEMISTRY APPLIED TO RAILROADS.

### V. PETROLEUM PRODUCTS.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.



(*Continued from page 126.*)

The discovery of petroleum certainly introduced marvellous changes in the oils used by railroad companies. The animal and vegetable oils which were almost exclusively used 20 or 25 years ago, as has already been remarked, have been largely displaced by the products of the refining and distillation of petroleum, and this encroachment of the petroleum products is not only in the field of burning oils, but also in the field of lubricating oils. There is scarcely any animal or vegetable oil used alone in either of these two fields, at the present time, so far as our knowledge goes. It is, of course, natural that this should be so, as the prices of the petroleum products, by the constant developments of the enormous petroleum industry have constantly diminished, while the animal and vegetable oils have in comparison been held at very much higher prices.

It is probably well known that petroleum, as it comes

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the Journal for December, is on the Work of the Chemist on a Railroad; No. II, in the January number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number are on Lard Oil. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these Contributions to Practical Railroad Information of special value in indicating the true character of the materials they must use and buy.

from the ground, is a mixture of hydrocarbons, which differ from each other, so far as their physical properties go, principally in their boiling points and densities; also that the crude oils from different regions of the country differ from each other quite considerably. In general, perhaps the best conception of the crude oil may be obtained by conceiving it to be like a right-angled triangle, the base of which represents the different chemical bodies which go to make up the oil, the perpendicular of which represents the successive temperatures at which the different constituents boil, and also the increase in specific gravity, which is characteristic of the different constituents, and the hypothenuse of which represents the boiling points and densities. Of course each region has its own characteristic triangle representing the oil, and it is also possible that the chemical bodies in the oils from the different regions are not entirely the same.

The composition of the crude oil being, as has been stated, a series of chemical bodies differing in boiling points, it is, of course, natural that the attempt to separate these different bodies should be by distillation, and accordingly, so far as we know, the first step in pretty nearly all refining of petroleum, after allowing the oil to settle for a while, is to put it into a still. Heat being applied, of course the constituents of the lower boiling point come off first. In general, we believe the condensed liquid is called "benzine," until the gravity reaches something like 60° or 65° Beaume's scale. Then comes, in general, the 110° fire-test oil, then the 150° fire-test oil, or higher fire-test oil, and still later the 300° fire-test oil. If the distillation is carried far enough nothing but tar remains in the still. If the distillation is stopped at the proper time, lubricating oil may remain in the still. Of course there are many modifications and characteristic methods of practice, which it would be inapplicable for us to give in detail, since we only care for general ideas as to the sources of the oils, which will be described later.

All the products of distillation as they come over are more or less contaminated with the heavier parts, and are more or less discolored from the presence of some of the tarry matters, which are either mechanically carried along or pass over in regular distillation. It is customary, we believe, to remove most of the color and tarry matters by treatment with oil of vitriol, which seems to have the power of combining chemically with the tarry matters and precipitating them to the bottom of the tank. Also some of the oils, especially the lubricating oils, are changed in color, and improved very much in appearance by filtering through bone black. The gasoline of the market is usually made by redistillation of the benzine, using vacuum, and, if we are rightly informed, in many of the best distilleries, most of the distillation throughout is carried on under the influence of vacuum. The paraffine oil, so called, we believe, is usually made by taking the tar, putting it into a smaller still, and subjecting it to distillation at considerably higher temperature, the distillation being practically carried to dryness, so that what is left in the still when the operation is complete is practically coke. This distillation may be repeated, if necessary, and then the product is paraffine wax and paraffine oil. The wax is usually separated from the oil by chilling and pressure in the same way that lard oil is separated from lard. A subsequent treatment of the oil with oil of vitriol improves the color very greatly, and gives, as will be described later, a very valuable lubricating oil.

Of all the enormous number of petroleum products which are now on the market, railroad companies commonly use five, we think, for lubrication and burning, and a sixth for burning is coming into use with the growth of the carburetter system of car lighting. The five are, 150° fire-test or headlight oil, 300° fire-test or car-lamp oil, paraffine oil for lubrication, well oil for lubrication, and 500° fire-test oil as a basis of cylinder lubricant. The sixth product, which seems to be coming into use, is gasoline. Of course, also, more or less benzine is used for cleaning and as solvent. Of these petroleum products specifications have been prepared for five; the question of specifications for gasoline is yet under consideration, and it seems probable that within a few months possibly specifications for this material will be issued. The grade of benzine used is ordinary 66° gravity Beaume's scale, and the purpose for which it is used, requires no special protection or guarantees.

The specifications for petroleum products have been revised two or three times during the last 12 years, as the growth in knowledge of these products has increased, and as the necessity for protecting the interests of the Railroad Company have demanded new tests. The following is the latest revision of the specifications for petroleum products on the Pennsylvania Railroad, dated, as will be observed, September, 1889:

PENNSYLVANIA RAILROAD COMPANY.

*Motive Power Department.*

*Specifications for Petroleum Products.*

Five different grades of petroleum products will be used.

The materials desired under this specification are the products of the distillation and refining of petroleum unmixed with any other substances, and conforming to the detail specifications below. Products having very offensive odor, or being mixed with other oils, will not be accepted. Shipments must be made as soon as possible after the order is received. All shipments received at any place on or after October 1, must show the proper cold test, and all received on or after May 1, must show the proper flash point, and will be rejected if they fail, even though the order did not call for winter and summer oil, respectively, unless it can be shown that the shipments have been more than a week in transit. No preliminary examination of samples will be required, but a limited amount of special preliminary examination will be made on the request of the Purchasing Agent, for use of parties desiring the information. When a shipment is received, a single sample will be taken at random and subjected to test, and the shipment will be accepted or rejected on this sample. If rejected, it will be returned at the shippers' expense.

The following detail specifications will be enforced:

150° FIRE-TEST OIL.

This grade of oil will not be accepted if sample:

1. Is not "water white" in color.
2. Flashes below 130° Fahrenheit.
3. Burns below 151° Fahrenheit.
4. Is cloudy, or shipment has cloudy barrels when received, from the presence of glue or suspended matter.
5. Becomes opaque, or shows cloud when the sample has been 10 minutes at a temperature of 0° Fahrenheit.

The flashing and burning points are determined by heating the oil in an open vessel, not less than 12° per minute, and applying the test flame every 7°, beginning at 123° Fahrenheit. The cold test may be conveniently made by having an ounce of the oil in a four-ounce sample bottle, with a thermometer suspended in the oil, and exposing this to a freezing mixture of ice and salt. It is advisable to stir with the thermometer while the oil is cooling. The oil must remain transparent in the freezing mixture 10 minutes after it has cooled to zero.

300° FIRE-TEST OIL.

This grade of oil will not be accepted if sample:

1. Is not "water white" in color.
2. Flashes below 249° Fahrenheit.
3. Burns below 298° Fahrenheit.
4. Is cloudy, or shipment has cloudy barrels when received, from the presence of glue or suspended matter.
5. Becomes opaque, or shows cloud when the sample has been 10 minutes at a temperature of 32° Fahrenheit.

The flashing and burning points are determined the same as for 150° fire-test oil, except that the oil is heated 15° per minute, test flame being applied first at 242° Fahrenheit. The cold test is made the same as above, except that ice and water are used.

PARAFFINE OIL.

This grade of oil will not be accepted if the sample:

1. Is other than pale lemon color.
2. Flashes below 249° Fahrenheit.
3. Shows viscosity less than 40 seconds or more than 65 seconds when tested as described under "well oil" at 100° Fahrenheit throughout the year.
4. Has gravity at 60° Fahrenheit, below 24° Beaume, or above 29° Beaume.
5. From October 1 to May 1 has a cold test above 10° Fahrenheit.

Smith's Ferry oil may be used interchangeably with paraffine oil, but viscosity and cold test must be same as for well oil,

and gravity at 60° Fahrenheit from 33 to 35° Beaume. It is not expected that Smith's Ferry oil can be used in winter.

The flashing point is determined same as for 300° fire-test oil. The cold test is determined as follows: A couple of ounces of oil is put in a four-ounce sample bottle, and a thermometer placed in it. The oil is then frozen, a freezing mixture of ice and salt being used if necessary. When the oil has become hard, the bottle is removed from the freezing mixture and the frozen oil allowed to soften, being stirred and thoroughly mixed at the same time by means of the thermometer, until the mass will run from one end of the bottle to the other. The reading of the thermometer when this is the case, is regarded as the cold test of the oil.

WELL OIL.

This grade of oil will not be accepted if the sample:

1. Flashes, from May 1 to October 1, below 249° Fahrenheit, or from October 1 to May 1 below 200° Fahrenheit.
2. Has a gravity at 60° Fahrenheit, below 28° Beaume, or above 30°.
3. From October 1 to May 1 has a cold test above 10° Fahrenheit.
4. Shows any precipitation in 10 minutes when 5 cubic centimeters are mixed with 95 cubic centimeters of 88° gasoline.
5. Shows a viscosity less than 55 seconds, or more than 100 seconds, when tested as described below. From October 1 to May 1, test must be made at 100° Fahrenheit, and from May 1 to October 1 at 110° Fahrenheit.

For summer oil the flashing point is determined the same as for paraffine oil; and for winter oil the same, except that the test flame is applied first at 193° Fahrenheit. The cold test is made the same as for paraffine oil.

The precipitation test is to exclude tarry and suspended matter. It is easiest made by putting 5 cubic centimeters of the oil in a 100 cubic centimeter graduate, then filling to the mark with gasoline and thoroughly shaking.

The viscosity test is made as follows: A 100 cubic centimeter pipette of the long bulb form, is regraduated to hold just 100 cubic centimeters to the bottom of the bulb. The size of the aperture at the bottom is then made such that 100 cubic centimeters of water at 100° Fahrenheit will run out the pipette down to the bottom of the bulb in 34 seconds. Pipettes with bulbs varying from $1\frac{3}{8}$ in. to $1\frac{1}{2}$ in. in diameter outside, and about $4\frac{1}{2}$ in. long give almost exactly the same results, provided the aperture at the bottom is the proper size. The pipette being obtained, the oil sample is heated to the required temperature, care being taken to have it uniformly heated, and then is drawn up into the pipette to the proper mark. The time occupied by the oil in running out, down to the bottom of the bulb, gives the test figures. A stop watch is convenient, but not essential in making the test. The temperature of the room affects the test a little. The limiting figures were obtained in a room at from 70° to 80° Fahrenheit. It will not usually be possible to make duplicate tests without readjustment of the temperature of the oil. Bullock & Crenshaw, 528 Arch Street, Philadelphia, can furnish the pipettes for making viscosity test. They should be ordered as "P. R. R. Viscosity Pipettes."

500° FIRE-TEST OIL.

This grade of oil will not be accepted if sample:

1. Flashes below 445° Fahrenheit.
2. Shows precipitation with gasoline when tested as described for well oil.

The flashing point is determined the same as for well oil, except that the test flame is applied first at 438° Fahrenheit.

THEODORE N. ELY,
*General Superintendent Motive Power.*

ALTOONA, PA., September 14, 1889.

The petroleum products being, as has already been described, the result of distillation, it is natural that the tests applied to determine the quality should be those having relation to the boiling points and densities. It will be observed that of the five petroleum products all of them have the flashing point taken and some of them the burning point. Much has been written and a large amount of experimentation has taken place with regard to the methods of taking flashing and burning points. In the burning oils, of course, the object of the determination of flashing and burning points is to secure an oil that is safe to use. In the lubricating oils the object of the determination of the flashing and burning points is to exclude those constituents which are poor lubricants. Those parts of the petroleum which are low in flashing point are so extremely limpid that they are practically of no value as lubricants with any pressures with which railroads have to do.

With regard to the burning oils we are hardly prepared to say that we think the method of taking the flashing and burning points which we commonly use, and which with more or less modifications is in common use everywhere, gives a perfectly safe oil, although it should be stated that with most lamp constructions which are in common use on railroads, an experience of now nearly 15 years shows that with oils which pass the tests given in the Pennsylvania Railroad specifications, explosions or accidents due to the oil almost never occur. In the two or three cases which have occurred some peculiarity in the use of the oil accounted for the accident. In one case a lamp was put behind a stove and the temperature of the oil became very high. In another case of headlight oil the lamp was so located that heat from the smoke-box heated the oil far above any safe limit of temperature. Notwithstanding this immunity from accidents, we are inclined to confess that the matter of the safety of the oil is more a question of the appliances used in burning the oil than the fact that the oil is perfectly safe to use. Moreover, interesting experiments were made a number of years ago by the Downer people, the results of which seemed to show that any lamp using an oil less than 300° fire-test, which lamp was perhaps not over half full of oil, might be in condition to explode almost any time after it had been burning for an hour or so, and apparently the reason why there were so few accidents with petroleum products is that the lamps are so constructed that the flame does not get to the space above the oil inside the lamp. Without going into minute details concerning these experiments, it may be stated that lamps were filled half full with different oils, and in place of the burner a hollow stopper, with a flap-valve opening downward, was put in each lamp, retained simply by friction alone. On allowing the lamp to stand even in the temperature of an ordinary room, and then slipping a lighted match down through the hollow stopper, an explosion results which closes the flap-valve and blows the stopper out. The experiments were varied likewise by having a lamp fitted with an electrical device which would fire the explosive mixture above the oil and blow the stopper out. The explanation of why lamps are in an explosive condition under the circumstances described, is perhaps not at all difficult to comprehend. As has already been described all the petroleum products are mixtures of hydrocarbons of different boiling points and densities, and the method of separation of these different constituents by distillation makes each resulting product have some of the higher and some of the lower of these constituents. For example, 150° fire-test oil is not exclusively a hydrocarbon which distills at a certain temperature, but a mixture of hydrocarbons of boiling points above and below the temperature corresponding to that at which most of the oil comes over from the still; in other words, ordinary 150° fire-test oil has some light oil in it and some heavier oil in it. This being granted, if the oil stands, as in a lamp half full, the tendency of the lighter parts, especially as the temperature goes up, is to separate from the mass of the oil and become a vapor mixed with the air in the lamp above the oil. If the proportions of air and oil vapor are right, this mixture is an explosive one, and, as stated above, the experiments of the Downer people seemed to indicate quite clearly that, with any of the marketable oils less than 300° fire-test, oil lamps, especially in warm weather, might be in a condition to explode. No oil is used, at least on the Pennsylvania Railroad, that is less than 150° fire-test, and if, as the experiments indicate, this oil, as commonly used in lamps, may be attended with some danger, still more so are the 110° fire-test oils known in the market as ordinary kerosene. Notwithstanding this difficulty, the experience of a number of years in using 150° fire-test oil has been so satisfactory, probably due, as stated above, largely to the appliances in which the oil is used, that very little anxiety is felt in using an oil which fairly passes the requirements of the specifications given above, and accordingly its use is continued in many places. In a subsequent article, however, it will be seen that no 150° oil even is used where it can have any chance to affect the safety of the passengers, with the bare exception of out-door lamps at small stations for lighting up the platform. It should also be stated that strenuous and earnest study is being

put on the question of using only 300° fire-test oil in all places as a burning oil. The appliances for doing this have not yet been fully developed, but very promising results have been obtained, and it is hoped that within a year or two no oil will be burned anywhere on the Pennsylvania Railroad which has a lower fire-test than that given in the specifications for 300° fire-test oil.

A small volume could be written on the method of making fire-tests, especially of the burning oils, and it should be confessed at the outset that the number of variables which affect the flashing and burning points of a good sample of oil are so great that it is not at all uncommon for duplicate samples out of the same can to give different results. In general the methods in use may be divided into two classes, namely, closed-cup and open-cup testing. Both of the methods have their advantages and apparently both their disadvantages. It is probable that the closed-cup method gives results which are the safest guide. On the other hand, the closed-cup method is very slow, and where a large amount of work is to be done is hardly available. We use exclusively the open-cup method of testing. The apparatus which we make use of is an ordinary small iron cup sand-bath placed above a Bunsen burner, which plays directly against the pan of the sand-bath and heats the sand. In the sand-bath an ordinary porcelain dish, such as are commonly used in chemical laboratories, about 2⅝ in. diameter inside and about 1 in. deep inside, is placed. This is filled to within ¼ in. of the top with the oil to be tested, the amount of oil under test being about one fluid ounce. A thermometer is suspended in about the center of the surface of the oil, so that the bulb is fairly immersed in the oil, but does not touch the bottom of the dish. As a test flame we use a very small gas-jet, about as big as the bead of flame on the end of a burning string. We usually draw out a glass tube to a fine aperture and allow the gas to pass through this aperture until we get the size of flame mentioned.

In our experience with open-cup testing, the following variables affect the flashing and burning points: First, rate of heating; second, size and depth of the cup used; third, amount of oil used; fourth, the thermometer; fifth, distance of the test flame from the oil; sixth, the size of the test flame; seventh, the length of time the test flame is held above the surface of the oil; eighth, the place where the test flame is held; ninth, how often the test flame is applied, and tenth, surrounding conditions and peculiarities of the apparatus and manipulator.

In view of this large number of variables, it is, perhaps, not surprising that there should be so much discrepancy in the fire-tests made by different parties, nor indeed surprising that duplicate tests out of the same can should not give exactly the same results. In our experience the most important variable is the rate of heating. It is entirely possible to take a sample of oil and get a higher fire-test by from 5° to 10°, by making the rate of heating very slow, over what would be obtained if the rate of heating was more rapid, and it is, perhaps, not difficult to see why this is so. The flashing point is in reality that temperature at which enough oil vapor escapes from the oil under test to mix with the air just above the surface of the oil and form a combustible or slightly explosive mixture. The burning point is the temperature at which the evolution of vapor from the surface of the oil is sufficiently rapid to maintain a flame. Still further, it is quite clear that as the oil vapor escapes from the surface of the oil it has a tendency to dissipate itself into the surrounding air. If, now, the rate at which the oil vapor is driven out of the oil is very slow, the dissipation may be almost proportional to the rate at which the vapor escapes from the oil, and consequently no accumulation of oil vapor sufficient to form a combustible mixture would take place. Under these conditions the oil would show a high fire-test. On the other hand, if the heating is more rapid, so that the evolution of oil vapor is more rapid, the flashing point will be considerably lower. So important do we regard this variable of rate of heating that we especially specify it in our specifications. It will be observed that for the 150° oil we raise the temperature of the oil not less than 12° a minute, and for all the other oils we raise the temperature not less than 15° per minute. Some of the petroleum refiners have regarded this as a little severe, and we find many of the so-called 150° oils of the market which will not stand test at this comparatively rapid heating. Our interpretation of the value of this test is that it is designed to protect the consumers of oil from using dangerous material, and not that it was designed to enable manufacturers to sell an oil of lower fire test. We have, accordingly, interpreted every one of the variables, especially in testing 150° oil, against the manufacturers. We conceive as long as this is thoroughly understood, that it is perfectly fair, and as long as we do not object to paying the price which is determined by open competition, in order to get the oil which we want, we do not see anything wrong in being strenuous in regard to the testing of these kinds of oils.

The size and depth of the cup affects the fire test in this; if the same amount of oil is in a large shallow cup, the dissipation of the oil vapor into the surrounding air is more rapid than if it is in a smaller sized deep cup, and the dissipation of the oil vapor being a function of the flashing and burning points, it is plain to be seen that these two variables would affect the test. Also whether the cup is filled nearly full or partly full affects the fire test. Quite elaborate experiments have been made by the German experimenters, on a means of getting duplicate tests to within one degree on the same sample of oil, and a deep cylinder filled about half full of oil has been found to give the nearest to uniform results of any method of testing. It is plain to be seen why this should be so, since that portion of the cylinder which is above the surface of the oil prevents the dissipation of the vapor, and, consequently, if the rate of heating and the other variables are uniform, duplicate tests on the same sample would have a much greater tendency to be the same.

The amount of oil affects the test, as is plain to be seen by virtue of the amount of vapor which is generated. With a large amount of oil, the same rate of heating and other variables uniform, a much larger amount of vapor will be generated in the same time than with a small amount of oil, and, consequently, the temperature at which the combustible mixture will be formed above the surface of the oil will be different than if a smaller amount of oil was used, since the rate of the dissipation of the vapor, as has already been stated, is a function of the test. It is obvious that if a large amount of vapor is furnished, the combustible or semi-explosive mixture will be sooner reached than if a smaller amount of vapor is furnished. The effect of the larger amount of oil is to make the test a little more severe on the oil.

The thermometer affects the test somewhat more in its unreliability than in any other way, it being a very common experience with thermometers that they are from 1° to 3° out in their readings, and also that a thermometer which has been used for some time, and especially if the same thermometer has been used to make high fire tests, as well as low, gives readings which are unreliable. We usually use what are known as the best chemical thermometers obtainable from the ordinary chemical supply dealers and discontinue their use after a few months.

The distance of the test flame from the surface of the oil makes quite a difference in the fire test. If the test flame is put down to within ¼ in. of the oil the flash and burn will be obtained considerably sooner than if the test flame is held ½ in. or ¾ in. above the surface of the oil. This is, of course, readily understood on the hypothesis previously suggested, that the flash and burn are simply mixtures of air and oil vapor, and it is obvious that the mixture of air and oil vapor, especially in the flashing point, would sooner reach the combustible point at ¼ in. above the oil than ¾ in. above the oil. We usually hold the test flame about ½ in. above the oil.

The size of the test flame has an influence in its effect on the generation of vapor from the oil. A bead of flame one-half as large in diameter as a lead-pencil and maybe ¼ in. long, will give a different result from a test flame as large as a lead-pencil and ¾ in. long. This is especially noticeable in burning point, not so much in flashing point.

The length of time that the test flame is held to the oil also has an influence in the effect of the flame on the oil. This is quite clear, we think, without explanation. If the flame is held within ¼ in. of the oil for some seconds it

will have a tendency to heat the oil at that point and thus cause the generation of vapor from the oil with a consequently lower test than if the test flame is simply applied and taken away again. We usually hold the test flame near the surface of the oil not more than perhaps a second. We do not, as is customary with many professional testers, pass the flame rapidly over the surface of the oil about ¼ in. away from it. We really do not have much objection to this method if the flame is passed across the dish, but our custom has been usually to hold the flame for at least a second about ¼ in. from the surface of the oil.

The place on the surface of the oil where the test flame is applied is a matter of considerable importance. If the test flame is held near the edge of the dish, a flash will be obtained at a number of degrees lower temperature than if the flame is adroitly passed down near the thermometer to within ¼ in. of the surface of the oil and as adroitly pulled out again. It is obvious why this should be so. At the edge of the dish the oil vapor and the air have the best chance to mix, while in the center of the dish, near the thermometer, the material may be largely oil vapor. The flame being held at the edge of the dish, where the mixture of oil vapor and air has the greatest probability of being combustible, we get a little severer test on the oil, perhaps, but we think one which protects the interests of the consumer better. A number of years ago, in the case of a dispute, the legalized oil-tester of Pennsylvania came to Altoona to test a shipment of oil which we had rejected. We furnished him the proper appliances, and in every respect he did the same as we do, except we were inclined to heat the oil more rapidly than he liked, and also we applied the test flame at the edge of the dish while he applied it alongside of the thermometer. This single variable of where the test flame was applied caused the rejection of this shipment, and he claimed his test was valid because the law of the State under which he was working did not specify where the flame should be applied. On the other hand, we claimed that the law of the State was designed to protect the consumer and not furnish facilities to dealers to sell low fire-test oil, and accordingly, since the law was silent, we were entirely at liberty to apply the test flame wherever we desired. Of course in this case no legal questions were involved, since the oil was bought on specifications, and our view of the case was sustained by the authorities. We are likewise inclined to think this view of the case would be sustained by the courts in case the question should go before them. In our view the place where the test flame is held in open-cup testing is the next most important variable after the rate of heating.

How often the test flame is applied affects the test of a very sensitive oil apparently by the influence of the test flame on the surface of the oil. If the test flame is applied every degree a considerably lower fire test will be obtained than if the test flame is applied as is our custom every 7°. It is plain to be seen that the influence of the heat of the test flame on a very sensitive oil would be considerable.

The surrounding conditions have some influence on the test of an oil, notably, the barometric pressure being quite low, the escape of the vapor from the surface of the oil is more easy than with a higher barometric pressure, and in a very sensitive oil this undoubtedly makes some difference. We had a case once in which we were utterly unable to account for the difference obtained in testing the same sample of oil with the same apparatus and same manipulator on several successive days except by the barometric pressure. Furthermore, currents of air passing over the dish are especially important surrounding conditions. It is very clear why this should be so. If the vapor is carried off by a current of air as fast as it is generated, it is obvious that the fire test will be considerably higher than if the vapor which comes out of the oil is allowed to accumulate over its surface. It is not always pleasant to make fire tests of oils in a closed room, but we are very careful in our work to have no currents of air to assist the dissipation of the oil vapor which is set free from the surface of the oil. It is also claimed by some experimenters that two pieces of apparatus for taking fire tests, which are made absolutely alike, as near as possible, will not necessarily give the same results. We have never experimented much in this field, but are inclined to think the difference due to the apparatus would not be very large. Also we find that with the same apparatus two manipulators may not necessarily secure the same result from the same oil, although they attempt to make the manipulation as near as possible alike.

In the next article we will continue the discussion of the testing of petroleum products, and if space permits, discuss briefly a few other oils which are or may be used by railroads. This will be followed by complete statements of how the various oils described in the previous articles are actually used on the Pennsylvania Railroad, including the formulas for the various mixtures, with notes drawn from the experience in the use of these oils during the last 15 years.

(TO BE CONTINUED.)

## THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.



(*Continued from page 137.*)

### CHAPTER II.

### The Use and Care of Drawing Instruments.

#### THE DRAWING BOARD.

To the description of the drawing board, which has already been given, it should be added that no oil, paint, varnish, or polish of any kind should be applied to any part of it. The board, when in use, should be inclined like the lid of a desk, and elevated high enough, so that when the learner stands up he will not be obliged to bend over too much to reach the middle of the board. In drawing a draftsman has much greater freedom of movement when standing than he has if he is sitting down. All young draftsmen are therefore advised to discard seats while they are drawing. A stool or step, 7 or 8 in. high, is often a convenience to stand on while drawing on the upper part of the board. This step can be pushed under the table on which the board rests, when not in use.

Care should be taken that no indentations or holes of any kind—excepting those left by drawing tacks—are made in the board, as it is impossible to draw a true line over such places, and the points of dividers and compasses are liable to punch unsightly holes in the paper if there is an indentation below it.

The board should be placed with its left-hand edge next the window, so that the light will fall from that side, and it will be found that light from the upper part of a window will give greater distinctness to lines on the paper than that coming from the lower part. It is a good plan, therefore, to have the window-curtains in a drawing-room to roll up at the bottom of the window instead of the top. In the northern hemisphere a window facing north gives the best light to draw by, as there is no sunshine from that quarter.

#### PAPER.

The paper should be fastened to the board with a drawing tack in each corner. It should be smoothed down by passing the hand from the center of the sheet outward toward the corners, so as to stretch it as evenly as possible. Additional tacks may be placed between the corners if required.

Paper which is kept for use should always be laid flat and not kept in rolls. If it is kept rolled it will curl up on the board and is thus difficult to smooth down evenly. If it must be rolled for transportation, the roll should be of as large diameter as practicable, so as to curl up the paper as little as possible. The same remarks will apply to finished drawings.

#### T-SQUARES.

It is not very important that the back or stock of the T-square should be exactly square with the blade, although it is well to have it as near square as it can conveniently be made. The edge of the stock, which bears against the board, should be made perfectly straight, or very *slightly* concave. If either the edge of the board or that of the stock is convex, the latter is liable to rock against the board, and thus the edge of the T-square may not be parallel in different positions, which will lead to errors and inaccuracies in drawing. If either or both are very *slightly* concave the T-square will always bear against the board without any liability to rock.

The upper edge of the T-square, which is used in drawing, must be perfectly straight, or as nearly so as it can be made.

To true the edge of the blade, first plane it as straight as it

can be made "by the eye;" then lay it on a smooth piece of paper or board and draw a fine line with a hard, sharp-pointed pencil or the point of a knife along the edge to be trued. Then turn the blade upside down and see whether the edge coincides exactly with the line thus drawn. If it does the edge is true, if not the error must be corrected.

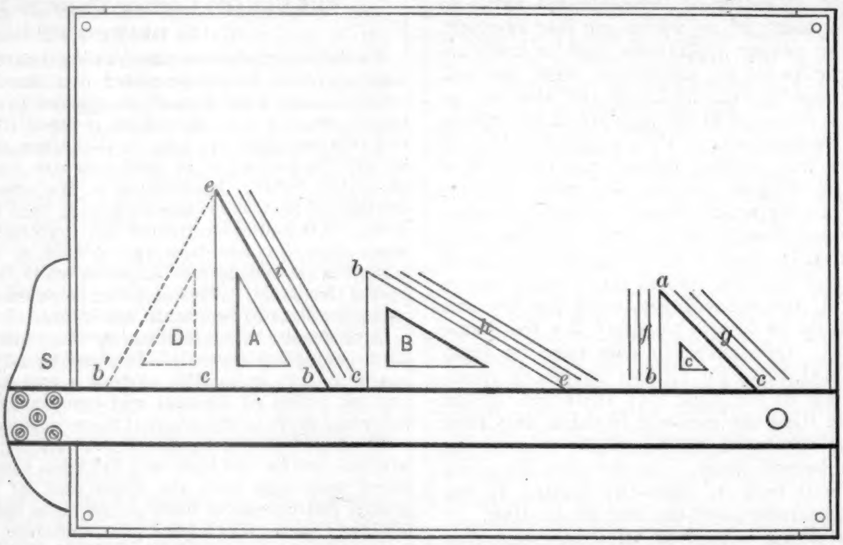
Another method is to place a straight-edge, which is supposed to be true, so that its edge and that of the blade coincide, and then hold them up to the light and see whether it shows between them. If one of them is slightly concave and the other convex, they may coincide so that the light will not show between them, yet neither will be straight. To get over this difficulty, a third straight-edge should be used to see whether the first and second both coincide with it. If they do they are all straight, and if they are not it will appear when the two, which are both either concave or convex, are brought into juxtaposition with each other.

Great care must be taken to protect the edge of the blade of the T-square from indentation or other injury, as the slightest notch or irregularity will be shown by every line that is drawn along the injured part of the blade. To protect it the T-square should always be hung up when not in use.

The edge of the blade should be square and not chamfered, or beveled, as it often is, as the square-edge gives much greater command over the position of the pen in inking drawings, and in drawing dotted lines the pen is apt to be lifted up above the edge of the blade if it is made too thin by beveling.

The T-square should be used with its stock, *S*, against the left-hand edge of the board, as shown in fig. 21, and all horizontal lines can be drawn with it. If it is used with its stock against the upper or lower edge of the board, unless the latter has been squared up recently it cannot be depended upon, and lines drawn from different edges of the board will not generally be found to be exactly at right angles or "square" with each other.

Fig. 21.




TRIANGLES.

It is of the utmost importance that the 90° angle of each of the triangles should be exactly "square." To ascertain whether it is square, place the triangle with its short side against the blade of the T-square, as shown at *A*, fig. 21, and draw a fine line along the side *e c*. Then, without moving the blade, turn the triangle over to the opposite side of the line, as indicated by the dotted lines at *D*, and then observe whether the side *e c* coincides exactly with the line which was drawn with the triangle in the first position. If the angle *e c b* is "square," the side *e c* when the triangle is in the opposite positions, will coincide exactly with this line.

The same directions which have been given with reference to having the edge of the T-square blade straight and preserving it from injury, will also apply to the triangles.

To draw a line perpendicular or square to the blade of the T-square, one of the triangles should be placed in contact with the blade of the T-square in either of the positions shown at *A*, *B*, or *C*, fig. 20. The stock of the T-square should be held firmly against the edge of the board with the left hand, and the triangle ought then to be pressed against the edge of the blade of the T-square, and the two must be securely held in that position. The line may then be drawn along the edges *e c*, *b c*, or *a b*, and it will then be perpendicular to any line drawn along the edge of the blade of the T-square, if its stock is securely held against the edge of the board when the line is drawn.

If the perpendicular line must be longer than the side of the triangle, then it should first be drawn as long as the triangle will permit, and the T-square can then be turned around and its blade laid so that its edge coincides with the line thus drawn, which can then be extended to the length required by drawing along the blade.

To draw two or more parallel perpendicular lines, as shown at *f*, the triangle *C* can be slid along the edge of the blade. To draw a line at an angle of 30° to a horizontal line, place the large triangle in the position shown at *B*, and draw along the edge *b c*. A line at an angle of 60° may be drawn by placing the triangle in the position shown at *A* or *D*, and drawing along *e b* or *e b'*, and one at 45° by placing the small triangle, as shown at *C*, and drawing along the side *a c*. To draw parallel lines at these angles, slide the triangles on the edges of the blade, and draw them as shown at *g h* and *i*.

DRAWING SCALE.

It would be desirable, if it were practicable, to make all drawings full size—and working drawings of machinery, when the parts are not too large, are usually made to that scale. The size of the objects to be represented is often so great though, that the drawings must be made smaller than full size. As beginners sometimes have difficulty in understanding how a reduced scale represents full sized dimensions, a little explanation may be needed. We may take, as an example, a locomotive driving-wheel of say 6 ft. diameter. If this were drawn full size the drawing would be over 6 ft. long and 6 ft. wide, which ordinarily would be inconvenient to handle. Therefore such drawings are often made to a scale of one-quarter of their full size. That is, any part of the wheel which is 1 in. long or wide is represented on the drawing as only $\frac{1}{4}$ in. long or wide. If it is 1 ft. long, it is only 3 in. on the drawing. This will be understood by referring to fig. 8,* which represents a two-foot rule one-quarter its full size. Now if we had a little rule of the size of the engraving, on which each inch was only $\frac{1}{4}$ in. and a foot only 3 in. long, then this would be a scale of quarter size, or of 3 in., equal to one foot. Drawing scales are graduated in a similar way, that is, the inches are $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, or $\frac{1}{16}$ in. long, and feet are 3, 2, $1\frac{1}{2}$, 1, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{3}{8}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{6}$, $\frac{1}{6}$, $\frac{1}{8}$, and $\frac{1}{16}$ in. long, and drawings made from them are said to be to a scale of 3 in., 1 in., $\frac{1}{8}$ in., etc., equal to a foot.

Drawing scales should be straight, or nearly so. If they are crooked they will not rest on the board steadily. The graduations, if examined with a magnifying glass, should not appear irregular or of varying size.

In laying down dimensions from a triangular scale the edge containing the scale to be used should be placed on the paper, and the measurements can then be marked either with the point of a pencil or pricked with the dividers. If the movable point shown at *A*, fig. 11,* is put into the pen-holder, fig. 12, it forms a convenient instrument for this purpose. Dimensions may be taken direct from the scale with a pair of dividers and transferred to the paper.

PENCIL.

All that need be observed with regard to pencils is that their points should be kept sharp. If they are made of the form of a chisel edge, as already remarked, they will remain sharp a longer time than if they are made round.

* See March number of JOURNAL.

DIVIDERS.

As their name implies, the chief use of dividers is to *divide* spaces into equal parts. They are also used for laying off dimensions which are taken from the scale, or from some part of the drawing. Their points should be of exactly the same length, and kept as sharp as needle-points. If they are allowed to become dull, they are liable to punch large holes in the paper. The compasses, fig. 10*, can be used as dividers by removing the pen *B*, and substituting the point *A*, fig. 11*. The spring dividers, fig. 11 or fig. 18, are used for small dimensions, and the joint compasses, fig. 10, with the point *A*, or the dividers, fig. 17, are used for larger dimensions.

In using dividers a novice is very apt to take hold of the legs, thinking that it can thus be held more securely. At the very beginning a learner should accustom himself to handle dividers and compasses by the joint alone, using only the thumb and the first two fingers.

COMPASSES.

The compasses are used chiefly for drawing circles or parts of circles, either with a pencil or ink. The joint compasses, fig. 10*, is used for circles and curves of from ½ in. up to about 3½ in. radius, and the spring compasses for circles and curves of ½ in. radius and less. The beam-compasses, fig. 19*, is used when the radius is greater than 3½ in. To draw circles or curves with a pencil, the holder, shown at *C*, fig. 19, is inserted in any one of the instruments, and the pen *B*, fig. 10, may also be used in any of them for drawing with ink. The pencil-holder and pen are held in each of these instruments with a clamping screw, shown in the engravings. The shanks of the pen, pencil-holder, and point *A*, fig. 11, and the sockets to receive them are made slightly tapered, so that if the screws are properly adjusted, the pen-holder or point may be removed and replaced without moving the screws.

In using the compasses, fig. 10, it is desirable that the leg which has the needle-point should always be perpendicular to the drawing or surface of the board. If it stands at an inclination, the needle-point will make an objectionably large hole in the paper when the compasses are turned in drawing a circle. If the pen does not stand perpendicular to the paper, then only one of its nibs or points will touch the paper, and either it will not mark at all or the line drawn will be ragged and irregular. It is also desirable that the pencil should always be vertical to the paper when the compasses are used. For these reasons its legs are jointed, so that they may be bent inward in proportion as the compasses are extended, and thus they may always be kept in a vertical position.

In using the beam-compasses, fig. 19, wooden sticks or beams of different lengths can be made as required, and the fixed head *D* is then fastened to them by the set screw *E*. The movable head *F* is adjusted in any desired position by the screw *G*. As it is difficult to adjust the pen or pencil at *C* very precisely by the sliding head *F*, the pen and pencil are attached to a bent spring, *B*, and their position is then regulated exactly by the nut *A*.

The pencil-holder consists of a tube split through part of its length, with a ring to move up and down, by which the hexagon lead from an ordinary HHHHHH pencil can be used in it, and is securely held by the movable ring.

In using compasses, as well as dividers, they should be handled by the joint alone, and the learner should not take hold of the legs excepting, perhaps, to steady the movable one in drawing large circles. In drawing a circle "begin it at the lowest point, holding the joint of the compasses between the thumb and the middle finger, the index finger resting lightly against the left side of the joint. Turn the compasses *with* the clock, describing the left half of the circumference by rolling the joint between the thumb and second finger ; that finger can go no farther, but its place is then easily and naturally taken by the first finger, and the joint is rolled between it and the thumb until the circle is completed, by one continuous motion. This requires a little practice, but the trick, if it is once acquired, is never forgotten, and the instrument is at all times under perfect control, with no danger of altering the radius.

"In setting the compasses to draw a circle of a given diameter, it is not enough simply to open the legs to the required radius, for it seldom happens that this can be done with exactness ; two short arcs should be struck, on opposite sides of the center, and the scale applied to see that the *diameter* is correct." †

The needle-point of compasses should be slightly longer than the pen or pencil, for the reason that the point enters the paper more or less when the instrument is in use, and the point of the pen or pencil should then be of such a length as to just touch the surface of the paper.

* See March number.

† Practical Hints for Draftsmen, by Professor C. W. MacCord.

PEN.

There is no instrument which will give the young draftsman so much trouble and perplexity as the drawing-pen, and there is none which requires so much skill and care to keep it in good condition. It consists of two blades, whose elasticity tends to separate the points, whose distance apart determines the width of the line which is drawn. They are adjusted by a screw, shown at *B*, fig. 10. The two blades should be made from a solid piece of steel cut apart. Pens are often made with one blade jointed, so that the two can be separated for convenience in cleaning, but the joint is liable to allow more or less lateral movement to one of the points. When this occurs the pen will not draw a smooth, sharp line, but the latter will be more or less ragged.

To draw a clear, distinct line the points should be rounded and sharp, but not keen enough to cut the paper, and they should be of exactly the same length. A fine oil-stone and a magnifying glass should be used in sharpening pens. To determine whether the points are of exactly the same length, hold the pen perpendicular to the surface of the left thumb-nail and make a mark on it with the points. If they are of the same length they will mark two lines on the nail, but if one is longer than the other it will make only one line. If that is the case, the points should be brought to the same length by a few light strokes on the oil-stone, while holding the pen vertically to its surface. If either of the points is dulled by this process, it must then be sharpened by rubbing its sides on the stone. Great care and delicacy are required in sharpening a pen and keeping it in good condition.

One important precaution which must be observed, in order to keep the pen in good condition, is that it should *always* be thoroughly cleaned after using it. The learner should preserve his worn-out linen pocket-handkerchiefs for this purpose. They have just the required softness and can be inserted between the points of the pens.

To charge a pen with ink, take a postal card and cut it into strips 3 in. long and ⅜ in. wide. Dip one end in the ink, which has been rubbed in a cup or saucer, and transfer that which adheres to the strip to the pen, by inserting the end of the strip between its points. By this means you avoid getting ink on the outside of the blades of the pen—as will be the case if it is dipped into the ink—which is quite certain to blot the paper.

It is essential that the pen should always be charged with fresh ink. After it has been in the pen for a few minutes it dries between the points and will not flow. When this occurs it should be cleaned and freshly charged. It is a good plan to keep a glass of water at hand, and in cleaning the pen first dip it into the water. This facilitates the removal of the dried ink.

The instruments which were illustrated in the March number of the JOURNAL are designed so that the same pen can be used for all of the compasses, and also for drawing straight lines by inserting it in a handle or holder shown in fig. 12.

In drawing straight lines, the pen should be held so as to be perpendicular with the surface of the paper, and the point nearest to the blade of the T-square, triangle, or straight-edge, which is used as a ruler, should bear against its upper edge. If it bears against the lower edge, the ink flowing from the pen is liable to come in contact with the ruler and blot the paper. When a pen will not mark satisfactorily, new beginners are apt to press it hard against the edge of the *T* square or triangle, and thus they press its points together, which prevents or obstructs the flow of the ink. The learner should aim to press the pen against the edge of the T-square or triangle only enough to keep it securely in contact and to prevent it from "running off the track." It will require some practice and patience to acquire the delicacy of touch and feeling to handle a pen satisfactorily.

INDIA INK.

All that need be observed in using India ink is that it be rubbed so as to be free from lumps. To do this dip your finger in a glass of water, and from the end of it drop eight or 10 drops of water into one of the ink saucers. Then rub the end of the stick of ink gently in the saucer until the liquid is dark black. To ascertain whether it is black enough, hold the saucer a little inclined for a few seconds. If the ink runs off of the bottom of the saucer so that the latter shows through the liquid, it is not dark enough, and more rubbing is required. If after rubbing the ink is lumpy, a cork or the end of the finger may be used to rub it to a condition of uniform consistency.

GENERAL REMARKS.

"In pencilling work be careful not to press too heavily on

your pencil; the lines should be so lightly done that they can, if required, be easily rubbed out with india-rubber, without disturbing the grain on the surface of the paper. Draw all pencil lines past each other at angles and intersections; for as the edge of the rule partly obstructs your view of the line when

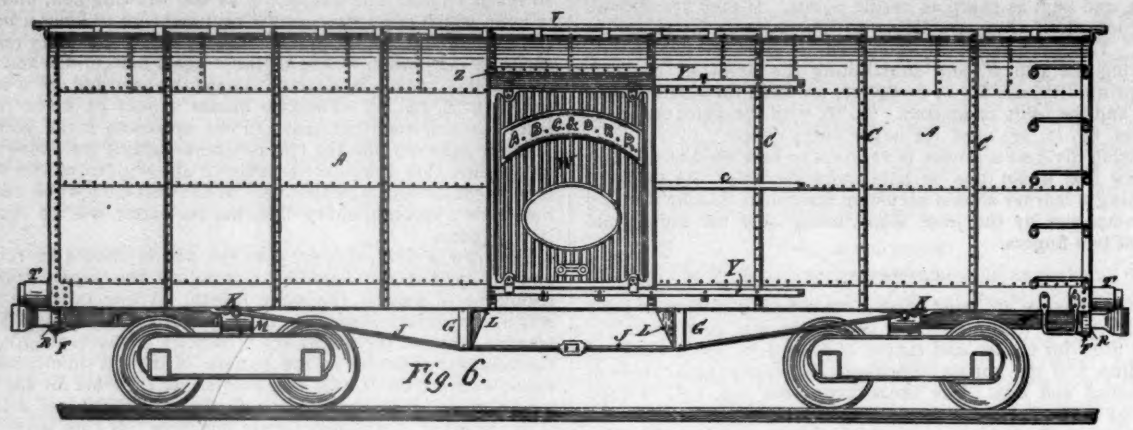


Fig. 6.

inking, you are liable to pass over the required point, which annoyance will be prevented by another pencil line crossing at the exact spot at which you are to stop." *

"Circles and circular arcs should, in general, be inked in before straight lines, as the latter may be more readily drawn to join the former than the former to the latter. When a number of circles are to be described from one center, the smaller should be inked first, while the center is in better condition." †

In drawing cleanliness is absolutely essential in order to good work. The hands, the instruments, the drawing board, the paper (and it may be added the conscience) should all be kept clean. A brush should always be at hand to clear away dust; and water, basin, soap, and towel are always needed. The drawing board ought always be covered when not in use. A sheet of any kind of paper is better than cloth for this purpose, because the latter lets the dust through; although a piece of oil or enamelled cloth is not open to this objection, and therefore makes an excellent cover. After being used for some time the T-square, triangles, scale, and drawing-board will become soiled. They should then be cleaned with a damp sponge and a little soap.

(TO BE CONTINUED.)

## Recent Patents.

### I.—HUGHES'S METALLIC RAILROAD CAR.

MR. EDWARD MACKENZIE HUGHES, of the Fox Solid Pressed Steel Company, of Chicago, has patented a metallic car illustrated by the engravings.

He describes his invention as follows:

Fig. 6 represents, generally, the body of the car, which has the general shape shown in section in fig. 7. Fig. 8 is a transverse section, and fig. 9 is a horizontal section of the end of the car. It is made of plates riveted together, as shown. The side-plates are flat, while the roof-plates are pressed to a curve, as shown. The plates of the sides and the ends of the car are lapped and riveted through an inside strip *B*. The carlings or supports for the sides and roof are shown at *C*, and are preferably made of a single piece carried from the side sills over the top of the car, as shown in fig. 7. These carlings may be of angle-steel riveted to the plates beneath. They are attached to the side sills by brackets, or in any suitable way.

The sills of the car *D* are made of channel-steel, and are attached at their ends by knee-pieces *E* to the end sills *F*.

The cross-ties *G* are made of pressed steel of the shape clearly indicated in fig. 7, and are shaped at the ends into descending brackets *H*, serving as king-posts or supports for the body truss-rods *J*, which are supported by the hinged connection from the side sills at *K*, as shown in fig. 6. These cross-ties may be braced by gusset-plates *L*, as shown in fig. 6, and upon these cross-ties *G* the longitudinal sills rest, as clearly shown in fig. 7.

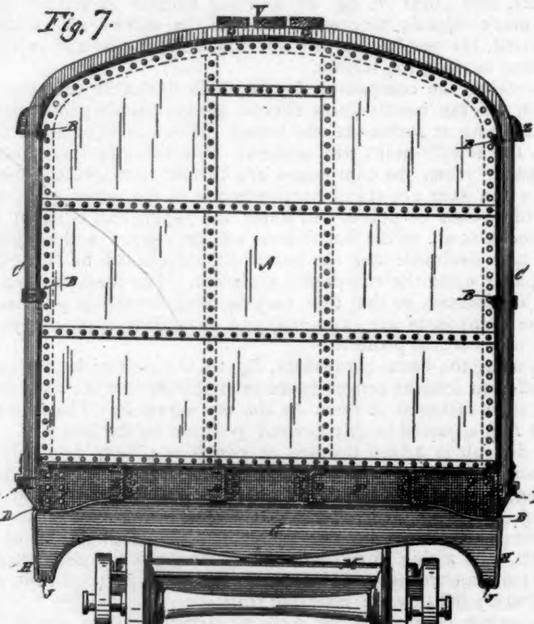
The body-bolster *M* is made of pressed steel, and preferably has a center-plate pressed therein.

* Drawing for Machinists and Engineers, by Ellis A. Davidson.

† Engineer and Machinists' Drawing Book.

The structure of the bolster, transom, and truck may be of any form desired. The draw-bar is attached to the body-bolster by plates *N N*, fig. 8, which are preferably flanged and riveted to the body-bolster. They are bent to form recesses upon their facing sides to receive the box for the draw-head, and are closed below the draw-head by a perforated plate *P*, as shown in fig. 8. The end sill, which is made of pressed steel, has a projection and an opening for the passage of the draw-head. The draft-

Fig. 7.



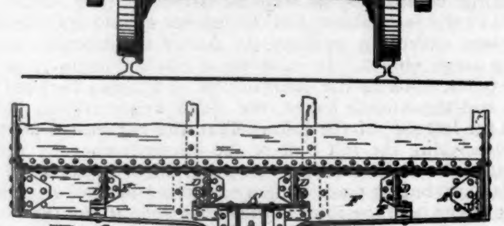


Fig. 8.

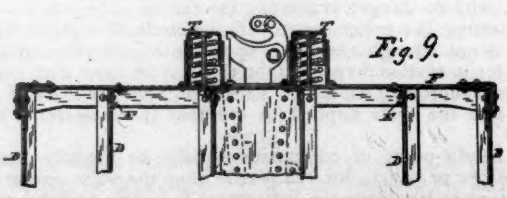


Fig. 9.

plates *N* are preferably attached at their upper ends to a plate *S*, riveted to the bottom of the center sills, as shown in fig. 8.

The buffers *T* are made of pressed-steel boxes fitting within

surrounding cylinders riveted to the end plates, as shown in fig. 9. They are, of course, provided with an interior spring, and their motion is limited by a longitudinal bolt.

A running plank *V*, fig. 7, may be provided on top of the car, and is intended to be the only wooden part of the structure, although an additional wooden roof may be employed.

The floor of the car consists of plates of metal riveted together, serving to brace and support the end sills and longitudinal sills. The structure is shown as applied to a freight-car; but it is in part applicable to passenger-cars.

II.—HUGHES'S SMOKE-STACK.

The inventor of the metallic car has also patented a smoke-stack made of pressed steel. It is shown in figs. 10 and 11.

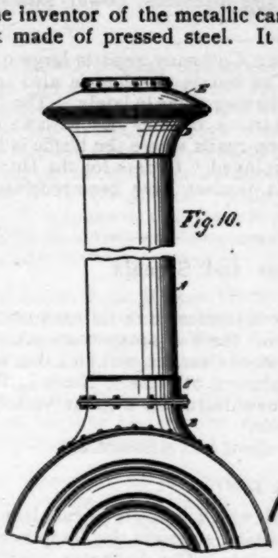


Fig. 10.

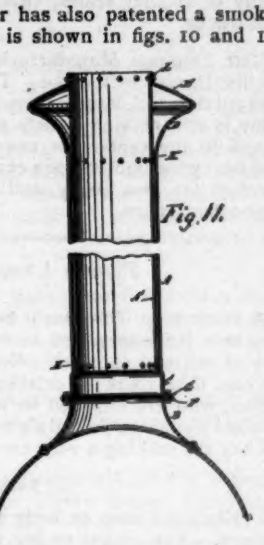


Fig. 11.

It consists of two cylinders of metal *A A'*, as indicated, between which the improved smoke-stack base and top are applied.

The smoke-stack base consists of two parts *B C*, which are formed of single pieces of steel pressed to a circular form, as indicated. The advantage of this arrangement is to insure tightness of fit between the parts which are pressed in dies, so as to make absolute contacts, and also to prevent any escape of the products of combustion or interference with the drafts. The part *B* is flanged outward into a bell shape, as indicated at the bottom, and cut away at the front and rear, so as to be shaped to the top of the boiler. It has likewise a flange *F*, as indicated, corresponding to a flange *G* of the part *C*. The part *C* is like-

Fig. 12.

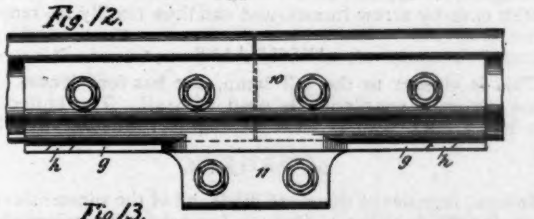
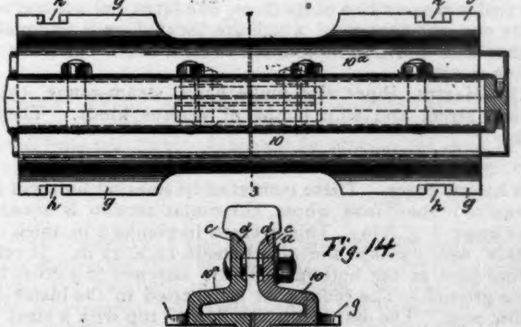


Fig. 13.



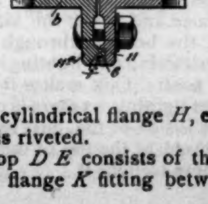


Fig. 14.

wise provided with a cylindrical flange *H*, entering between the parts *A A'*, where it is riveted.

The smoke-stack top *D E* consists of the two parts shown, the part *D* having a flange *K* fitting between the parts *A A'*, and the part *E* a flange *L* for riveting upon the pipe *A'*. The parts *D E* fit each other exactly, and are supported in position by the upper and lower riveting, as indicated. By making these parts of continuous pressed steel, as indicated, the weight of the front of the engine is lightened, which is a great advantage at that point, where weight is useless, and the fittings themselves are superior, owing to their great strength, lightness, and cheapness.

III.—LYND'S RAIL-JOINT.

Mr. Ives Lynd, of Troy, N. Y., has patented the rail-joint illustrated by the engravings, which are so clear that they do not require any description. It is shown in figs. 12, 13, and 14—fig. 12 being an elevation, fig. 13 a plan, and fig. 14 a cross-section of the rail and joint.

IV.—MORGAN'S RAIL-JOINT.

Mr. Richard Price Morgan, of Dwight, Ill., has patented the form of rail-joint illustrated in the engravings herewith, which is shown in figs. 15, 16, 17, 18, 19, 20, and 21, and which he describes as follows:

"Beneath the abutting ends of the usual track-rails *A* and *A'* extends the sub-rail *B*, the body of which comprises a top

Fig. 15.

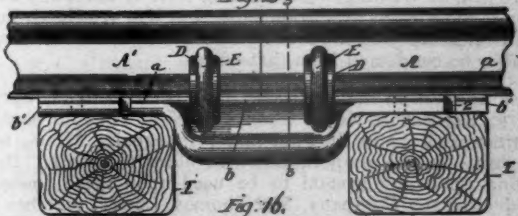


Fig. 16.

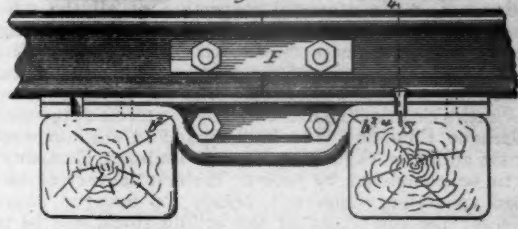
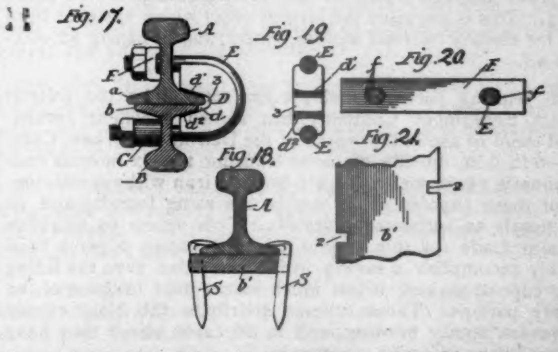


Fig. 17. Fig. 19. Fig. 20. Fig. 18. Fig. 21.



flange *b*, corresponding in general contour with the contour of the flanges *a* of the track-rails above it. The sub-rail *B* has its ends formed with the flattened or reduced portions *b'*, that rest upon the surface of the cross-ties *T*, and by preference, also, these flattened or reduced ends of the sub-rails are expanded to a width greater than the width of the flanges of the track-rails, as more particularly seen in fig. 18, in order to permit the expanded ends of the sub-rail to be furnished with suitable slots 2, fig. 21, through which will pass the spikes *S*, that serve to firmly hold the sub-rail to the cross-ties. By thus flattening the ends of the sub-rail *B* all necessity for the cutting away of the upper face of the cross-ties is avoided, and a very material saving in expense is thereby secured; and by laterally expanding the ends of the sub-rail to such an extent as to give to these ends a width greater than the width of the superposed track-rails I not only secure broad bearing ends, and thereby save the wear upon the ties, but I am enabled, also, to provide the ends of the sub-rail with slots for the spikes, and thereby secure a much more effective spiking of the sub-rail to the cross-ties than was possible with my prior construction, in which no such expansion of the ends of the sub-rail was made. The body of the sub-rail *B* is also preferably formed with the somewhat square or abrupt shoulders $b^2$, fig. 16, which will bear against the sides of the ties *T*, and will thus serve to better maintain the track in position. Upon the flange *b* of the sub-rail and upon

the flanges *a* of the track-rails are set the jaw pieces or blocks *D*, that are furnished with suitable seats or indentations *d*, to admit the flanges of both the track-rails and the sub-rail. The seats *d* of the jaws *D* are formed with the bearing-surfaces $d^1$ and $a^2$, adapted to bear, respectively, upon the upper faces of the flanges of the track and sub rails."

# Manufactures.

## Manufacturing Notes.

THE International & Great Northern Railroad has just placed an order with the Scarritt Furniture Company, St. Louis, for 174 Scarritt-Forney seats of the latest pattern for some very handsome new cars now building. The Chicago & West Michigan Railroad is building six new passenger cars to be furnished with seats of the same pattern. These seats have also been adopted by the Chicago & Alton, the Cleveland, Cincinnati, Chicago & St. Louis, and other prominent roads for their new equipment.

THE firm of Westinghouse, Church, Kerr & Company has recently established its fifth branch office, at No. 511 North Fourth Street, St. Louis, and the southwestern business of the firm will hereafter be conducted from that office.

IT is announced that contracts have been let to the Sprague Electric Railway & Motor Company, New York, to equip all the street-car lines in St. Paul and Minneapolis, Minn., which are owned by one corporation, with electric motors. Before deciding upon any system to be used upon these roads, the President of the Company, Mr. Thomas Lowry, together with the directors, made a careful inspection of all the different methods of operating street cars in large cities, and investigated the merits of each. As a result of this investigation contracts for the partial equipments of the road by cable were cancelled, and negotiations were entered into with the Sprague Company for the entire electrical equipment. By the terms of the contract the Sprague Company is to fully equip and put into working order the entire mileage owned by the Railroad Company, the work to be completed by June 1; the first delivery of electric railroad apparatus, which will include 400 Sprague improved motors for the equipment of the rolling stock, will be made shortly. This is probably the largest order which has ever been given for electric railroad motors, amounting to nearly $2,000,000 in all.

THE Whiting patent cupola, manufactured by the Detroit Foundry Equipment Company, has shown excellent results. One of them in use in the works of the Detroit Car Wheel Company—6 ft. 6 in. outside diameter—during the six months ending January 1 last, melted 13,416 tons of iron without relining. Four of these cupolas are in use in the same foundry and all show nearly as satisfactory results. This seems to establish the claim made for this cupola, that the patent tuyeres used not only accomplish a saving in fuel, but also save the lining of the cupola, making it last much longer than in those of the ordinary pattern. These tuyeres distribute the blast evenly and prevent spotty burning, and in all cases where they have been used have met with approval.

AMONG other orders recently received by the Bucyrus Steel Shovel & Dredge Company, Bucyrus, O., is one for three large steam shovels for the Lake Shore & Michigan Southern Railroad, making seven of these tools furnished to this road. Two of these are the heaviest and strongest ever built, carrying a three-yard dipper and having a capacity of 300 cubic yards in 10 hours.

THE business of the Rollstone Machine Company, of Fitchburg, Mass., has been transferred to a new company recently organized at Anniston, Ala. New buildings are now under construction which will be equipped with tools of the latest pattern, and the transfer will be made about April 1 next.

THE Simonds Rolling Machine Company, Fitchburg, Mass., is making extensive additions to its plant, and is going largely into the manufacture of rolled specialties for railroad work, such as car coupling pins, etc.

AT the Philadelphia Testing-Machine Works of Riehle Brothers, the orders recently received include a United States standard screw-power testing-machine of 35,000 lbs. capacity for the Polytechnic Institute of Alabama, and one of 20,000 lbs. for the Portage Iron Company, Duncansville, Pa.; a transverse testing-machine of 20,000 lbs. capacity for the Tamarack-Osceola Company, Dollar Bay, Mich., and one of 5,000 lbs. for the West Superior Iron Company; a cement tester, 1,000 lbs., for the Missouri Pacific Railroad; track-scales for the Crane Iron Company, Catasauqua, Pa., and for Lees & McVitty, Salem, Va.; charging scales for the Wheeler Furnace Company, West Middlesex, Pa., and the Cranberry Coal & Iron Company, Cranberry, Tenn.; 2,000 lbs. standard test weights for E. P. Allis & Company, Milwaukee, Wis.; Robie screw-jacks (30-ton) for John Lawlor, Prairie du Chien, Wis., the Norfolk & Western Railroad, Roanoke, Va., the Crane Iron Company, Edgehill, Pa., and (10-ton) for H. H. Hobson, Brandon, N. Y.; also for many of smaller scales, twisting machines, power sandsifters and trucks.

THE Dunham Manufacturing Company reports large orders for its Davies lock spike. The Servis tie-plate is also in increased demand, large orders having come in lately. The Company is now making a new pattern, heavier and with an extra flange in the center, for use on roads where the traffic is large and heavy locomotives are employed. Orders for the Dunham car door are also heavy, and a number have been received for Globe ventilators.

## Piper's Lamps and Signals.

A VISITOR to Toronto, if he is interested in railroad matters, may be a little surprised to find there a prosperous manufactory of railroad supplies. Nevertheless, he will find that to be the case if he visits the establishment of Messrs. Noah L. Piper & Son, who are engaged in manufacturing a great variety of railroad signal lamps and signals.

They are making a very excellent and substantial

TAIL LAMP,

the cylindrical case or body of which is made of cast-iron galvanized. The socket or leg which supports the lamp is made hollow to admit air for ventilation. The discharge ventilator on top is detachable and can be taken apart to facilitate cleaning. It has deflectors on the sides which direct the current of air, produced by the wind, upward, which thus protects the lamp from being blown out. The lamp also has a central tube in its oil reservoir to prevent the splash of the oil from the motion or concussion of the train, and a small conical ventilator is also attached to the reservoir to allow any gas which may accumulate in it to escape. The air which is admitted at the bottom through the hollow socket is conducted up through openings on each side of the lamp reservoir, and the currents are thus subdivided to greater steadiness to the flame.

The case has generally two Fresnel lenses on opposite sides, although three are sometimes used. All of these are attached to the case by screw frames, and can thus readily be removed.

BUFFER LAMP.

This is similar to the tail lamp, but has four lenses. The same system of ventilation is used with all. The buffer lamp also has a back light to show the engineer whether it is burning.

SWITCH LAMPS.

Several varieties of these are made, all of the substantial character described. One of these is for a three-throw switch. It has two lenses on two of its faces, one large red one and a small white one, the centers of which are located on a diagonal line, so that their position in relation to each other will show which switch is open.

The Messrs. Piper also make hand, steam-gauge, caboose, station, street and ship lamps of various kinds. They also make

SEMAPHORE SIGNALS

with hollow posts. These consist of an internal lining of heavy galvanized sheet iron whose horizontal section is square, the sides being 8 × 8 in. This is cased in planks 2 in. thick on the outside, which makes the post outside 12 × 12 in. It rests on a cedar post at the bottom which is attached to a cross buried in the ground. The cedar post is inserted in the inside of the hollow post. The latter has a pulley on top with a steel chain running over it to raise and lower the lamp. The post has an opening and door at the bottom, through which access may be had to the lamp for trimming and lighting, after which it is hoisted to the top of the post. This makes it unnecessary to go to the top, and facilitates lighting, as there is much better protection from the wind on the inside of the post below than there would be if the lamp is exposed at the top of the post, and the attendant must climb up there to light it.

The colored lenses are attached to a rectangular case on the inside of the post and outside of the lamp. This case is operated by a rod which connects it with, and is moved by, the semaphore, the position of which determines that of the lenses.

Mr. Piper is also the inventor of a system of interlocking signals for railroad crossings and drawbridges, which is very ingenious. He has applied the same system of signals to gates for street crossings, and he has models of all of them on exhibition in his warehouse, which at present is opposite the Rossin House.

## Bridges.

THE following bridge companies are actively at work putting in plants for the manufacture of steel eyebars; Pencoyd Bridge & Construction Company; Phœnix Iron Company; Passaic Rolling Mills; Smith Bridge Company; King Iron Bridge & Manufacturing Company; Elmira Bridge Company. It is probable that of the several processes of upsetting the grooved die, the nest of rollers and the rocking half-roller will each have a trial. It is rumored that there is a patent now being perfected by which upsetting and forging may both be accomplished at once under the steam hammer.

THE Edge Moor Bridge Works have secured extensive contracts from the Norfolk & Western Railroad, including the heavy steel bridge across the Ohio at Ceredo, and a large coal dock at Norfolk, besides much small bridge work.

THE Kansas City, Fort Scott & Memphis Railroad has let the contract for five plate-girder spans to the Pencoyd Bridge & Construction Company.

THE shop work on the Memphis Bridge will shortly be commenced at the Athens shop of the Union Bridge Company. The bridge will be entirely of steel and will comprise a continuous superstructure 2,258 ft. 4 in. long, built on the cantilever principle, and a deck span 338 ft. 9 in. long. The continuous superstructure will be composed of a central span 621 ft. $0\frac{1}{2}$ in. long, from each end of which projects a cantilever arm 169 ft. $4\frac{1}{2}$ in. long; of an anchorage span 225 ft. 10 in. long, from which will project a cantilever arm like those above mentioned and two intermediate spans each 451 ft. 10 in. long. The continuous superstructure is, therefore, divided into one span of 225 ft. 10 in., one of 790 ft. 5 in. and two of 621 ft. $0\frac{1}{2}$ in. The 790-ft. span will be the longest cantilever span in this country, and will exceed the Red Rock Bridge, now under construction, by 130 ft. The estimated weight is 13,000,000 lbs. for the continuous superstructure, and 1,000,000 lbs. for the deck span.

THE contract for the extension of the Hudson County Elevated Railroad of Jersey City from the present terminus to the Court House, was let to the Passaic Rolling Mill Company, Paterson, N. J. The work is now in the shops and being turned out rapidly.

## OBITUARY.

HENRY WOODS, who died in Ottawa, Canada, March 8, aged 67 years, was for 20 years in charge of the construction of bridges on the Grand Trunk Railway. For a number of years past he had been Bridge Inspector on the Canadian Pacific.

ASSISTANT NAVAL CONSTRUCTOR CHARLES H. HEWES, U.S.N., died of typhoid fever in Norfolk, Va., March 18. He graduated from the Naval Academy in 1883, at the head of his class, and was regarded as one of the best of the younger officers in his department of the service.

LEONARD EVERETT, a well-known and wealthy engineer and dredging contractor, died at Lockport, N. Y., March 18, aged 70 years. He was born at Canton, Mass. At the time of his death he was General Superintendent of the American District Steam Company, which has plants all over the country.

EBENEZER L. ROBERTS, who died in Brooklyn, N. Y., March 13, aged 65 years, was born in Middletown, Conn., and trained as a practical builder. In 1850 he removed to New York and became a very successful architect and builder. He had charge of the construction of a number of large buildings, including those of the Standard Oil Company and the Ninth National Bank on Broadway, several churches, and many private residences. He also built the Amherst College gymnasium and other buildings in various parts of the country.

## PERSONALS.

ARTHUR POU has been appointed Chief Engineer of the new Florida, Midland & Georgia Railroad.

MAJOR H. WADSWORTH CLARKE has been appointed City Engineer of Syracuse, N.Y. He is an engineer of wide experience.

L. M. BERRIEN has been appointed Principal Assistant to the Chief Engineer of the New York, New Haven & Hartford Railroad.

LOCKWOOD, GREENE & COMPANY, Engineers and Mill Architects, have removed their office to the Rialto Building, 131 Devonshire Street, Boston.

JOHN WILEY & SONS, the well-known publishers of engineering and scientific books, have removed their offices from No. 15 Astor Place to No. 53 East Tenth Street, New York City.

HON. WARNER MILLER, of New York, has been chosen President of the Nicaragua Canal Construction Company, succeeding A. C. CHENEY, who remains with the Company as Vice-President.

E. A. CANNON, for the past two years Assistant U. S. Engineer in charge of the Elk River Division of the Muscle Shoals improvement in the Tennessee River, has resigned, and will return to Minneapolis, Minn.

JOSEPH W. SILLIMAN, C.E., has been appointed Professor of Engineering in Allegheny College, Allegheny, Pa., to succeed W. S. TWINING, who has resigned in order to accept a position with the Thomson-Houston Electric Company of Boston.

ARTHUR CRANDALL has been appointed Secretary of the Dunham Manufacturing Company, with office in the Phœnix Building, Chicago. He has for some time represented the Company in Chicago and the Northwest.

M. F. BONZANO has been appointed Assistant General Superintendent of the Philadelphia & Reading Railroad. He has been on the road 10 years, serving as Supervisor, Division Engineer and Division Superintendent.

CHARLES BLACKWELL has resigned the office of Assistant Superintendent of the Toledo, St. Louis & Kansas City Railroad, and has accepted a position with the manufacturing firm of Shoenberger & Company, of Pittsburgh.

C. H. WALTON has been appointed Superintendent of the Cincinnati & Muskingum Valley Railroad, in place of F. G. DARLINGTON, who is appointed Division Superintendent of the Chicago, St. Louis & Pittsburgh Railroad.

CAPTAIN N. H. FARQUHAR, U.S.N., has been appointed Chief of the Bureau of Yards and Docks in the Navy Department, with the relative rank of Commodore. Captain Farquhar was in command of the *Trenton* when that vessel was lost at Samoa.

JAMES MCCREA has been chosen Second Vice-President of the Pennsylvania Company, to succeed the late William Thaw. Mr. McCrea's successor as General Manager of the Company's lines is JOSEPH WOOD, heretofore General Superintendent of Transportation.

FRANK S. GANNON has been appointed Eastern General Superintendent of the Baltimore & Ohio, and will have general charge of all that company's interests east of Philadelphia. He will continue to act as General Superintendent of the Staten Island Rapid Transit lines.

ROBERT I. SLOAN, late Chief Engineer of the Manhattan Elevated Railroad in New York, has been appointed Chief Engineer of the new Southside Elevated Railroad in Chicago. His successor as Chief Engineer of the Manhattan Elevated is JOHN WATERHOUSE, heretofore Principal Assistant Engineer.

CHARLES WATTS has been appointed General Superintendent of the Pennsylvania Company's lines, including the Pittsburgh, Fort Wayne & Chicago and allied lines. Mr. Watts has had nearly 25 years' experience, serving as conductor, station-master and as Trainmaster of the New York Division of the Pennsyl-

vania Railroad, and for some time past as Division Superintendent of the Chicago, St. Louis & Pittsburgh Railroad.

## PROCEEDINGS OF SOCIETIES.

**American Institute of Mining Engineers.**—The spring meeting of the Institute began in Washington, February 18, the sessions being held in the National Museum. The usual addresses of welcome were made and responded to, and memorials of Dr. Ashburner and Franklin B. Gowen were read.

On the second day the members took an excursion to Mount Vernon in the morning. In the afternoon a business session was held, at which papers were read by H. Mendenhall on Standard Weights and Measures; by John Birkinbine on Magnetite in the Mines at Port Henry; and by F. A. Pocock on Electricity in Mines, the last-named paper describing the electric haulage at the Hillside Mine in Scranton. Papers were also read by Richard Pearce and F. H. McDowell.

On the third day, in the morning the members visited the Navy Yard, in the afternoon attended a reception at the White House, and in the evening the annual banquet of the Institute, which was held at the Arlington Hotel.

On the fourth day two sessions were held, which were chiefly given up to reading and discussing papers upon Aluminum. These papers were by Messrs. A. E. Hunt, G. H. Abbott, E. H. Cowles, W. H. Keep and F. P. Dewey. In these papers and in the discussion many interesting facts were stated in regard to the present condition of the manufacture of aluminum, and its use in alloys with other metals.

At the closing session the annual reports were presented, showing the Society to be in good condition financially, with a total of 1,968 members. Professor S. Munroe read a paper on Modern Methods in Surveying.

This closed the business of the meeting, but on the next day, February 22, a number of the members visited by invitation the gold mines now being developed in Montgomery County, Md., 15 miles from Washington.

**Association of Manufacturers of Chilled Car-Wheels.**—The regular meeting was held in New York, November 21, Mr. W. W. Snow in the chair. Mr. Whitney presented a report regarding the action of the Master Mechanics' and Master Car-Builders' Association with reference to the Conference Committee report. This enclosed the form of specifications for cast-iron wheels which was adopted by the Master Mechanics' Association in 1888, and by the Master Car-Builders' Association—with some slight modifications—in 1889. These specifications have been already noticed. The Report of the Committee concluded with the following resolutions and was accepted by the meeting:

"*Resolved*, That this Association accepts, with satisfaction, the action of the American Railway Master Mechanics' and of the Master Car-Builders' Associations, upon the report of the Joint Conference Committee on Specifications and Guarantee for Chilled Cast-iron Wheels, with the understanding expressed in the following preamble and resolutions:

"'*Whereas*, the wheel-maker has no control of the conditions of railroad service,

"'*And whereas*, such conditions vary materially on different roads, Therefore, *Resolved*—

"'1. That in all mileage or time guarantees, the wheel-maker ought to be held responsible only for wheels which fail through faults of material or workmanship.

"'2. That when wheels are taken out of service on account of sharp flanges, flat spots, comby or shelled-out treads, or for cracked brackets or plates, and it is found on breaking up the wheels that the depth and character of the chill and the strength and character of the metal in the plates are up to the standard specifications adopted by the Joint Conference Committee of the American Railway Master Mechanics', the Master Car-Builders', and the Wheel-Makers' Associations, it shall be considered that the failure is due to the service, and not to the quality of the wheel, and that the wheel-maker ought not to be called upon in such cases to pay for or replace any such wheels.'"

The following officers were elected: President, Frank J. Hecker; Vice-President, W. W. Snow; Secretary, William W. Lobdell; Treasurer, N. P. Bowler; Members of the Executive Committee, John R. Whitney, N. S. Bouton, W. S. G. Baker, C. H. Zehnder, and T. A. Griffin.

At the evening session a committee was appointed to confer with the Master Mechanics' and the Master Car-Builders' Association with reference to the subject first expressed in Mr. Whitney's report and resolution. The President appointed the Executive Committee for this purpose.

Resolutions were presented and passed, expressing respect for the late William H. Barnum. Notice was given that a motion would be made to amend Article III. of the Constitution. It was resolved that the next annual meeting be held in New York on the fourth Wednesday in October, 1890.

**International Association of Car Accountants.**—The Committee on Discussion has issued a circular suggesting the preparation of papers to be read at the annual convention, and asking members to prepare such papers. The Committee suggests the following as good subjects for papers:

1. Straight Per Diem; its advantages over mixed.
2. Mixed Per Diem; its advantages over straight.
3. The cause of the constantly decreasing mileage of freight cars on home lines; what are the remedies?
4. The Car Record Office. Presentation of some form of blank by members, with explanation of its presumed superiority over others—for example: Record Books, Foreign Record, Conductors' Bills, etc. (Not more than one or two kinds of blanks will be considered.) Work in Car Record Office, Unnecessary Work, Piece Work, Passenger Car Records and Mileage.
5. Traveling Car Agents; how their work should be done to be most effective.
6. Car Distribution; how best attained; limitations.
7. The Demurrage Bureaus. What has the experience of a year shown as to their efficiency?
8. Detention of foreign cars on roads, and what should be done to prevent it.
9. Diversion of cars and the advisability of adopting pecuniary penalties to remedy it.

Answers should be sent to the Chairman of the Committee, Edmund Yardley, at Pittsburgh, not later than April 15, when the Committee will make a selection and assign a time for reading each paper to the Convention.

**National Electric Light Association.**—The annual meeting of this Association was held in Kansas City, Mo., February 11, 12, 13 and 14. Besides the general routine business, a number of interesting papers were read, including, among others, one on the Economic Generation of Steam, by George H. Babcock; on Safety Devices in Electrical Installations, by Professor Elihu Thompson; on Electric Railroads, by F. J. Sprague. All these papers and others were discussed. Reports were received from the Committees on the Duty on Copper; on Underground Conduits; and on Standard Potentials for Street Railroads.

The following officers were elected for the ensuing year: President, M. J. Perry, Providence, R. I.; First Vice-President, E. A. Maher, Albany, N. Y.; Second Vice-President, C. L. Edgar, Boston; Executive Committee, C. R. Huntly, Buffalo, N. Y., Chairman; E. R. Weeks, Kansas City; James E. English, New Haven, Conn.; J. J. Burleigh, Camden, N. J.; M. D. Law, Philadelphia; M. J. Francisco, Rutland, Vt.; A. F. Mason, Boston; J. A. Seely, H. K. Thurber, New York.

The standing committees for the ensuing year are on Revision of the By-Laws and Constitution; on Underground Conduits and Conductors; and on Relations between Parent and Sub-Companies.

**American Society of Civil Engineers.**—At the regular meeting, March 5, Dr. Charles E. Emery described the construction of the plant of the New York Steam Company, stating the difficulties encountered and the methods adopted to overcome the same. His paper was illustrated by stereopticon views. The discussion was postponed to the next meeting.

It was announced that the amendment which consisted of a codification of the present text of the Constitution had been adopted; also the amendment to Article IX. It was also announced that the memorial to Congress reported by the Committee on Union Standard Time in favor of 24-hour notation had been adopted. The tellers announced the following elections:

*Members*: Henry W. Ayres, New Britain, Conn.; George H. Clark, Cedartown, Ga.; Potter D. Ford, Long Island City, N. Y.; Thomas J. McMinn, New York.

*Juniors*: Kennerly Bryan, Charles F. Parker, New York; Philo S. Perkins, Elmer W. Ross, Irving S. Wood, Providence, R. I.; Clark W. Thompson, Duluth, Minn.; Ernest J. Purslow, Santa Barbara, Cal.; Owen L. Ingalls, Washington.

At the regular meeting, March 17, Dr. Charles E. Emery continued his description of the details of construction of the plant of the New York Steam Company, which was begun at a previous meeting, stating in general the difficulties encountered and the methods adopted to overcome the same, and discussing the measure of success attained with district steam systems in New York and elsewhere, and the probable future of enter-

prises of this kind. The subject was illustrated by stereopticon views, and a discussion by the members present followed.

**American Society of Mechanical Engineers.**—The twenty-first Convention of this Society will be held in Cincinnati, O., beginning on the evening of Tuesday, May 13. Papers for this meeting are already in the Secretary's hands, and queries for the Topical Discussions should be sent in at once.

The meeting occurs the week before the great musical festival in the same city, making it possible for members who desire it to attend both reunions.

**New England Railroad Club.**—At the annual meeting in Boston, March 12, the following officers were elected: President, George Richards; Vice-President, Orlando Stewart; Secretary and Treasurer, Francis M. Curtis; Executive Committee, George Richards, F. D. Adams, J. N. Lauder, Albert Griggs, J. W. Marden, F. M. Twombly, and John Coghlan; Finance Committee, George Richards, Charles Richardson, Isaac N. Keith, Daniel S. Page, A. G. Barber, Osgood Bradley, Joel Hills, and George H. Wightman.

The subject for discussion being Freight-Car Couplers, the Secretary read the circular sent out by the Executive Committee to the trainmen of the New England railroads, asking them to signify their preferences for the various styles of couplers. The result of the investigation was given simply by announcing that the total number of signers was 1,948. Of this number 1,239 preferred the Safford, 557 the Janney, 63 the old style link-and-pin, 30 the Boston automatic, 26 the Gould, 25 the Miller hook, 5 the Marks, 2 the Dowling, and 1 the Cornell. The Committee deemed it best to combine the replies into two types, and by doing that 1,282 approved the Safford link-and-pin type, and 641 favored the Janney vertical-plane type.

The discussion was carried on by Messrs. Adams, Marden, Shinn, Coghlan, Lauder and others, who gave some accounts of experience on their respective roads with different types of couplers.

**New England Water-Works Association.**—The quarterly meeting was held in Boston, March 12. In the morning the members visited the works of the Hersey Meter Company in South Boston.

At the meeting several papers were read. One, by Mr. Horace Holden, on Water Rates, called out a long discussion, in which many members took part.

**Boston Society of Civil Engineers.**—At the regular meeting, February 19, Frederick W. Farnham, Willard M. Foster, Alfred E. Nichols and T. S. Pearson were chosen members. The President announced the death of Lincoln Cabot, a member, at Honolulu in December last. William E. McClintock was elected Vice-President, and Professor W. S. Chaplin a director for the ensuing year.

Captain Eugene Griffin, General Manager of the Railroad Department of the Thomson-Houston Electric Company, read a paper on the Transmission of Power by Electricity. This paper was discussed by Messrs. Blodgett, Pearson, Tilden and others.

**Engineers' Club of Philadelphia.**—At the regular meeting, March 1, the Secretary presented, for Mr. Howard Constable, an illustrated paper on the Re-enforcement or Underpinning of the Iron Piles of a Draw-bridge Pier.

Mr. Barton H. Coffey presented a paper on Sand Filtration. This was discussed, Mr. Howard Murphy expressing the opinion that some day it would be necessary to adopt a separate system of water supply to furnish the comparatively small quantity required for strictly personal and domestic uses from pure sources, while other sources not capable of yielding potable water could be drawn upon for the large quantities required for manufacturing and general uses.

Mr. Henry G. Morris described a new method of Sinking Dies, showing a specimen of the results, which, he said, could be obtained by this process at a much lower cost than by the old method.

**Engineers' Club of Kansas City.**—At the regular meeting, February 3, a committee was appointed to arrange for the annual dinner on February 28.

Mr. Thomas Knight read a paper on Geological Field Work in Southern Missouri, the object of the work being to ascertain the mineral resources of the country and the best plans for their development.

¶ **Engineers' Society of Western Pennsylvania.**—At the regular meeting, January 21, John M. Goodwin, H. S. Morris, F. S. Smith, L. B. Stillwell and William Whigham were elected members. The Treasurer presented a report showing expenditures of $1,447 for the year, and a balance of $280 on hand. The Secretary reported that there were now 336 members, and that 10 meetings had been held during the year.

It was resolved to adopt the report of the Committee on Union of the Various Societies, and also resolved that the Society is ready to join with others in occupying a common home under suitable conditions when offered by the Pittsburgh Academy of Science and Art.

The following officers were elected for the ensuing year: President, W. L. Scaife; Vice-Presidents, Phineas Barnes and A. E. Hunt; Directors, R. N. Clarke, W. G. Wilkins, William Metcalf, and M. J. Becker; Secretary, S. M. Wickersham; Treasurer, A. E. Frost.

Mr. J. A. Brashear read a paper on the Refinements of Modern Measurements and Manipulation, describing a number of the devices invented for making fine and close measurements.

**Civil Engineers' Club of Cleveland.**—At the regular meeting in Cleveland, O., February 11, Arndt Angstrom and James Wallace were chosen members.

Mr. Edward Lindsley read a paper on Improvement in Railroad Terminal Facilities, in which he reviewed the appliances for transferring heavy freights and unloading vessels.

Mr. James Ritchie read a paper on Specifications for Steel and Iron, in which he advocated the adoption of standard specifications for steel, with certain requirements for tensile strength, elongation, etc. This was discussed, bringing out some interesting statements about the relative advantages of steel and iron.

Mr. W. H. Kingsley read some notes on the Water Works Lake Tunnel, speaking of the difficulties encountered in building the tunnel under the lake at Cleveland.

President Holloway made some remarks about the American Society of Mechanical Engineers, and its new quarters in New York.

**Western Railway Club.**—At the regular meeting in Chicago, March 18, the first subject for discussion was the Interchange Rules, the object being to suggest changes which may seem expedient to present to the Master Car-Builders' Convention in June.

The second subject was Counter-balancing Locomotives, which called out a very lively discussion, many members taking part.

**Engineering Association of the Southwest.**—At the regular meeting, February 13, Berien L. Blackie was chosen a member; Alfred Hume, J. Price Jackson, and Tyler Calhoun, Juniors. In view of the number of non-resident members, it was resolved to hold one meeting in three at some point outside of Nashville, and to postpone for the present the furnishing of permanent quarters in that city. A number of photographs of bridges was received. A resolution for the appointment of a special committee on Highway Reform was referred to letter-ballot.

Mr. Linn White read a paper on a Passenger Incline Railroad on Cameron Hill, Chattanooga, Tenn., describing the road which was built by Messrs. Guild & White for the Chattanooga Water & Power Company, and was opened for traffic in October last. This paper was discussed by members present.

At the regular monthly meeting which was held in Nashville, March 13, Charles O. Bradford, James A. Fairleigh, Joseph W. Walker and Bernard A. Wood were chosen members; William M. Leftwich, Jr., a junior. The appointment of a special committee of five members on Highway Reform was ordered. A communication was received from the *Tradesman* of Chattanooga, offering a cash prize of $25 for the best paper read before the Association by any member between December, 1889, and April, 1890, the award to be made by the Executive Committee. The proposition was accepted.

Mr. C. A. Locke read a paper on the Government Survey of the Cumberland River below Nashville in 1889, which contained an account of the regimen of the river, the results of the examination for suitable sites for locks and dams and an exhibit of the results of the improvement on navigation. A discussion followed, in which Mr. Joseph W. Walker submitted drawings and descriptions of a form of movable dam in consideration for this river. Dr. W. L. Dudley submitted an analysis of a peculiar mineral found in borings near the mouth of the river, and

Professor F. W. Clarke pronounced the mineral a very peculiar one.

A Paper by Mr. George Reyer on Tests of the Pumping-Engines of the Nashville Water Works was read by title only, and will be published.

The April meeting will be held in Louisville, and will be devoted to the subject of heavy submerged bridge foundations.

**Northwest Railroad Club.**—At the monthly meeting in St. Paul, March 8, the subject for discussion was Journal Brasses. It was opened by Mr. G. S. Warren, who read a paper giving the results of some tests and experiments made with different brasses on both iron and steel journals. The discussion was continued by Messrs. Sceets, Whitaker, Pattee, Fraser, Barber, Ward and others, many different opinions being expressed both as to the best form of brasses and the metal to be used. The discussion was not finished, the subject being continued to the April meeting.

**Engineers' Club of St. Louis.**—At the regular meeting, March 5, William A. Neff, Jr., and Julius Pitzman were elected members.

Mr. Willard Beahan read a paper on American and Foreign Railroads, giving the results of observations in Panama, South America, France, England, Scotland and Ireland. Some de scription was given of the topography of the countries traversed, from the point of view of a railway locating engineer. The road-beds of the railroads were described, together with their ties, rails, ballast grades, curves and bridges. Some information was also given as to the locomotives used, and the rolling stock, speed, and the class and nationality of men employed to operate the roads. Comparisons were made between American and foreign railroads on the points of original cost, maintenance and operation, showing wherein American roads excelled and wherein they might learn something. The iron ties used in South America were described. A brief description was also given of the Forth Bridge. The discussion was participated in by Messrs. Robert Moore, J. B. Johnson, Meier, Ferguson, Curtis, Crosby, Long and Gayler.

Mr. Moore stated that lignum-vitæ ties were being used successfully in Mexico. Their cost was about $1 each, and they lasted indefinitely.

At the regular meeting, February 19, William E. Barnes, Emerson McMillin, and John H. Pope were elected members.

A paper by Mr. Edward H. Connor on the Substructure of the Cairo Bridge was read. It was accompanied by drawings, showing the piers and caissons, and explaining the work of construction in detail. This paper was generally discussed by members present.

Mr. Willard Beahan gave some information regarding the outlook for engineers in South America. He stated that railroads were few, but a number were projected, and that municipal engineering was just being taken up. Most of the engineers now in that country are French.

**Montana Society of Civil Engineers.**—At the regular meeting in Helena, February 15, O. C. Dallas, Frank C. Jones, James L. Buskett and Finlay McRae were chosen members.

It was ordered that the following standard Committees be appointed for the current year: On Public Works; on Affiliation with the American Society of Civil Engineers; on Public Land Surveys; on Library and on Topics.

The Committee appointed on the Revision of the United States Mining Laws made an interesting report of progress, and was continued to make a final report at the next meeting.

**Tacoma Society of Civil Engineers and Architects.**—At the regular meeting in Tacoma, Wash., February 20, H. C. Ward was elected a member.

The new President, Mr. D. W. Clarke, made a few well-chosen remarks as an opening address for the year.

Mr. C. E. Grafton read a paper on the Bituminous Coal-Fields of Pennsylvania. In the discussion which followed some points were brought out in relation to the coal-fields of Washington. As to extent and quality they seem to compare well with those of Pennsylvania, but mining is somewhat more difficult, as the dip of the measures is 30° to 40°, against 15° to 20° in Pennsylvania. In Washington there are no good indications of oil or natural gas, but limestone, marble and building stone are abundant. The precious metals are also successfully mined in some parts of the State. Its resources are now being rapidly explored and developed.

## NOTES AND NEWS.

**New York State Canals.**—The annual report of Mr. John Bogart, State Engineer of New York, for the year ending September 30, 1889, is chiefly devoted to the improvements made in the canal locks. Since 1886 the length of the locks has been doubled in 27 cases on the Erie Canal, and seven others are now under construction, and will be finished by the opening of navigation this spring. Seven locks on the Oswego Canal have been lengthened, and two others are under construction. The new locks are 220 ft. in length, between gate-posts. This makes a great saving of time, as two boats can be passed through the new locks at once, and there is no delay where boats are run in pairs, which is now a common practice on a canal.

The report says that the machinery for drawing ascending boats into the locks has been improved by the substitution of iron frames in place of old timber frames. These are neat and strong, and save much time both in hauling in boats and starting them out. Wire cables were tried with machinery, but have not proved satisfactory, as they are heavy to overhaul, and wear rapidly, so that they break easily. Experiments were made with regard to the advantage of opening one or more of the paddle-valves in the gates and thus drawing a boat into the lock and flushing it out more quickly than could otherwise be accomplished. It was found that in drawing in boats only one paddle could be used advantageously, because with more than one the boat is likely to damage the gates and coping. In swelling out the gain in time with three paddles was found to be very slight over two paddles, so that it is now considered advantageous to use one paddle in drawing in and two in swelling out. By this means there is shown a gain in time of about 20 minutes per lock. The introduction of the turbine wheel to run machinery for hauling ascending boats into the locks is a great advantage. Indeed, without such machinery it would be difficult to get a double-header into a lock.

The average evaporation in the canals during the dry season is estimated at 33⅓ in. daily. The loss from leakage and filtration is estimated at 229.3 cubic feet per mile. The use of double-headers necessitates the widening of the towpaths, and 18 ft. has been decided upon as the standard width of a towpath, that being the least width in which two triple teams can pass.

With regard to the improvement of the Hudson River between Troy and Coxsackie, the report declares that unless the United States Congress directs vigorous action immediately to this work the State of New York will have to exert itself to insure free navigation in that part of the Hudson River. Dredging has been carried on in the Albany Basin during the year, but the sewage of Albany is again filling up the basin. The State Engineer recommends the radical remedy of a sewer emptying below the basin.

The report urges the continuation of improvements on the Champlain Canal until the whole canal is of the enlarged size of 6 ft. depth, 56 ft. width on water surface, and 44 ft. width on bottom. The importance of the Champlain Canal is shown by the tonnage of 1,168,304 tons carried in 1888, which is fast increasing.

The Black River Canal is referred to as of great value to the northern ports of the State, where a large lumber business is transacted. This would not be possible without water transportation. During the year improvements were made on the Cayuga and Seneca and Chemung canals, and a survey was made of the Genesee Valley. The result of the latter is the conclusion that a storage-reservoir of remarkably large capacity can be constructed.

The total engineering expenses for the fiscal year were $86,-280. The organization of the department is reported to be substantially the same as in previous years. The engineering and clerical staff now consists of 3 division engineers, 3 resident engineers, 9 assistant engineers, 13 levelers, 15 sodmen, 20 chainmen, 1 chief clerk, 1 engineer in charge of the work of the department connected with the lands of the State, 1 canal clerk, 1 stenographer, and 1 clerk.

**A Chief Engineer's Duties.**—The following circular, issued by the Union Pacific Company on January 1, defines the duties of the Chief Engineer of that road: "From this date he will have on the entire system:

"1. Charge of surveys and reconnoissances of all proposed new lines, and reports thereon.

"2. Charge of construction of new lines, and of all structures and work pertaining thereto, including, except in special cases, the procurement of right of way.

"3. Charge of the inspection of truss bridges and tunnels, and supervision of important repairs or renewals connected

therewith, and the inspection of all structural iron in its manufacture.

"4. The preparation of plans and specifications for, and construction of, all important special structures, such as shops, division terminals and depot buildings, for which special plans are required, and the preparation of all important yard plans.

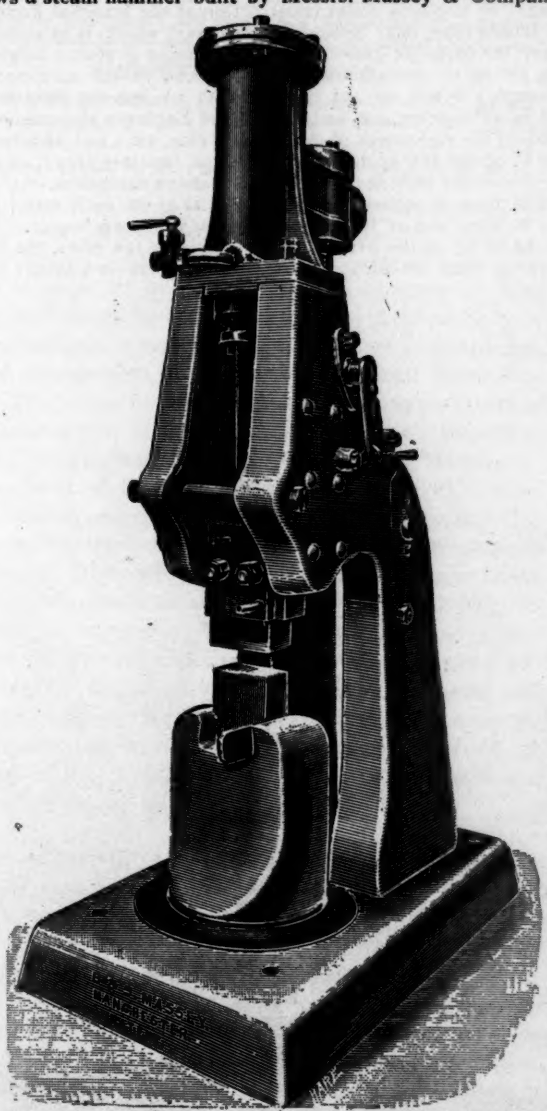
"5. The preparation and approval of standard plans for the maintenance and renewal of roadway, track, and roadway materials, buildings, bridges, and all other structures.

"6. The preparation and charge of right-of-way and lease records; preparation and charge of mileage and distance records, of all main tracks, sidings, spurs, etc., of every description. Also records of track composition, ballast, and tie charts.

"7. The preparation and care of records of bridges, buildings, and all other structures.

"8. And such other work as may be assigned by the Vice-President, to whom he will report direct."

**A Steel-Frame Hammer.**—The accompanying illustration shows a steam hammer built by Messrs. Massey & Company,



of Manchester, England. It is an ordinary small double-acting hammer, the peculiarity being that the frame used is of steel instead of the ordinary cast-iron frame. The standards and base-plate are made of Siemens-Martin steel, flanged by a steam forging press. There is no welding whatever, and the opening for the anvil-block is punched through the base-plate. The two standards are held together by bolts, as shown in the illustration, and the guides for the hammer-head are riveted on as indicated. This form of frame is covered by a patent issued to Messrs. Massey.

**A New Ocean Steamer.**—The Compagnie Générale Transatlantique will this year have a representative in the latest class of the ocean steamers, in the steamer *La Touraine*. The construction of this vessel is now going on at the yards of the company at Penhoet, near St. Nazaire, France, where their previous ships have also been built. The plans for *La Touraine* indicate that her speed will be much greater than that of any of her predecessors. She will be 8,000 tons burden, or 1,000 tons larger than the *Bourgogne*, *Bretagne*, *Gascogne*, and *Champagne*, while her H.P. will be increased from 8,000, as in the older boats, to 12,000 She will be provided with twin screws, and with a triple-expansion engine of the type which was first introduced on Atlantic lines by the French line. The general appearance of *La Touraine* will be much the same as that of the last two steamships built at Nazaire—the *Champagne* and the *Bretagne*. The metallic portions of the hull are of the highest grade of steel from the foundries of Terre Noire, and the woodwork is of teak and Canadian elm. The decorative work will be the best that French art can contrive, and the famous *cabines de luxe* of the older vessels will, if possible, be surpassed. Like all French mail steamers, the *Touraine* is built under contract with the Government, and will be fitted for the carrying of heavy guns. It is expected that *La Touraine* will be completed in time to make her maiden trip in April next. There is also in course of building at Penhoet a new steamship for the Transatlantique's Mexican line, running from St. Nazaire to Vera Cruz. This vessel is to be named *La Navarre*. She will be of 6,300 tons, and will develop 7,000 H.P. Her speed will be such as to admit of her being placed on the New York line, if necessary. Two other passenger steamers for the Algiers line, the *Maréchal Bougaud* and the *Ville d'Alger*, are also being built. They will be like the present *Eugene Perière*, and of 2,000 tons and 3,000 H.P.—*The Steamship*.

**The St. Clair Tunnel.**—The construction by the Grand Trunk Railway Company, of the tunnel under the St. Clair River, between Port Sarnia, Ont., and Port Huron, Mich., has slowly progressed during the past two years. The undertaking has proved to be difficult and expensive, involving an immense outlay of money in preliminary and experimental work. The length of the tunnel will be 6,000 ft., of which 3,310 ft. will be under the river, 2,160 ft. under dry land on the Canadian side, and 2,330 ft. under dry land in Michigan. Of the portion under the river, 1,500 ft. will be nearly level. At either end of this part of the tunnel, there will be a great rising, at the rate of 105.6 ft. per mile, which will continue through the open cuttings from the approaches. The total length of the ascent at the Canadian end will be 4,970 ft., and at the American end, 4,900 ft. The length of the open cutting at the east end of the tunnel will be 3,270 ft., and at the west end, 2,300 ft. The depth of the lowest part of the tunnel below the surface of the water will be 88½ ft. The minimum depth of the top of the tunnel below the bed of the river will be 15 ft. The tunnel will be for single track only. In cross-section it will be circular, with a clear internal diameter of 20 ft. The lining will consist of cast iron, of which about 6,000 tons have been manufactured and delivered upon the ground ready for use. The construction of the tunnel is being carried on by the company without contractors.

The plant consists of winding engines, ventilating machinery for exhausting foul air, with a capacity of 600,000 cu. ft. per hour; steam-pumps, with capacity of 5,000 gals. per minute; electric light plant; shields weighing 60 tons each for the protection of the men at work, hydraulic machinery for propelling the shields, with a power of 3,000 tons each. As the work is progressing from both sides of the river all work is in duplicate.

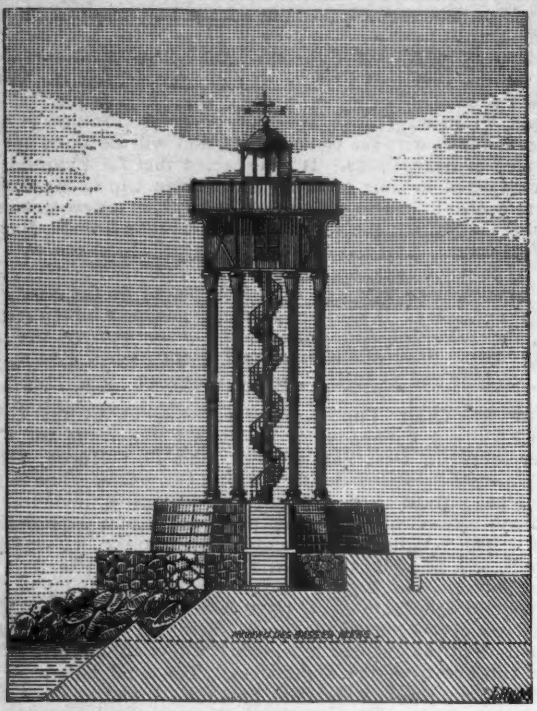
The advantages to be gained by the construction of the tunnel are a reduction of the expense and time of transporting trains, and a degree of regularity in the service not attainable by ferry, in consequence of the river being obstructed by ice in winter and by vessels during the season of navigation. The tunnel is being built at this particular point for the following reasons: The comparatively shallow depth of water at the proposed crossing; the tunnel and its approaches can be constructed on the same straight line; the short length of new railroad that will be required for all practical purposes; the tunnel approaches connect immediately with the main lines of both the Grand Trunk and the Chicago & Grand Trunk railroads; the favorable material in the bed of the river, the borings showing that the rock is from 90 to 95 ft. below the surface of the river, and that it is overlaid with clay.

The tonnage passing up and down the river is estimated to be nearly five times as much as that passing through the Suez Canal. The necessity of a tunnel is shown by the immense amount of traffic that is annually carried on across the St. Clair River in connection with the Grand Trunk Railway. During the year ended June 30 last, 184,000 through cars and 13,500 local cars were transferred by ferries here, making a total of 197,500 cars that passed over that year. This is an average of over 541 cars per day, including Sundays, or about 2.26 cars per hour, which is equivalent to the crossing of a boat-load of cars every 48 minutes.

The total cost of the tunnel is estimated at $2,500,000, of which the company has been granted a subsidy of $375,000 by the Dominion Government. The present pay-roll averages about $9,000 per month.

It is expected that this great work will be completed by the last of the year 1890.—*Report of Consul J. S. Farrar to the State Department.*

**A French Lighthouse.**—The accompanying illustration, from *Le Genie Civil,* shows a lighthouse recently erected at the



extremity of the breakwater at Port Vendres. It stands in a very exposed position, where high waves frequently break over it, and the intention was to combine strength of construction with the least possible resistance to the force of the waves.

The lighthouse is supported on six metallic columns arranged in the form of a hexagon. These columns are 14.50 m. (47.56 ft.) in height and are 2.20 m. (7.41 ft.) apart. Each column is formed of three parts; the lower is 0.30 m. (11.8 in.) exterior diameter, and is sunk 2 m. (6.56 ft.) in the solid masonry which forms the base of the tower. The middle section has the same diameter, but somewhat less thickness, and is joined with the lower one by means of a threaded sleeve. The upper part is joined to the middle section in the same way, and is united at its upper end with the metal framework which forms the floor of the light-chamber or lantern. The beams supporting the light-keeper's room are carried on brackets attached to the upper end of the second section of the column. The floor of this chamber unites the columns, the space below being left entirely clear, except as noted, in order to oppose least resistance to winds and waves.

The supporting columns were made especially for this work. They are of rolled iron welded on a mandril. This construction required some special arrangements which increased the price of the work, but was adopted because it presented the greatest possible strength in relation to the weight.

The lightkeeper's chamber, underneath the lantern, is reached by a winding staircase, which is supported by a central column which runs the whole height of the lighthouse, and upon which directly rests the lamp in the lantern. The risers of this staircase are of cast-iron and rest upon four tenons, which allow them to pivot freely about the central column. The treads and the railing are also of iron and can be easily and quickly removed, so that in case of a threatening storm, they can be taken from their places, and the risers, which form the frame of the stairway, can be swung around in the direction in which they will present the least resistance to the waves. Although the staircase is thus dismounted, the risers or frame still form a ladder by which access can be had to the light in case of necessity. The waves at this point frequently reach to the bottom of the light-keeper's room, which is 16 m. (52.48 ft.) above the general level of the break-water.

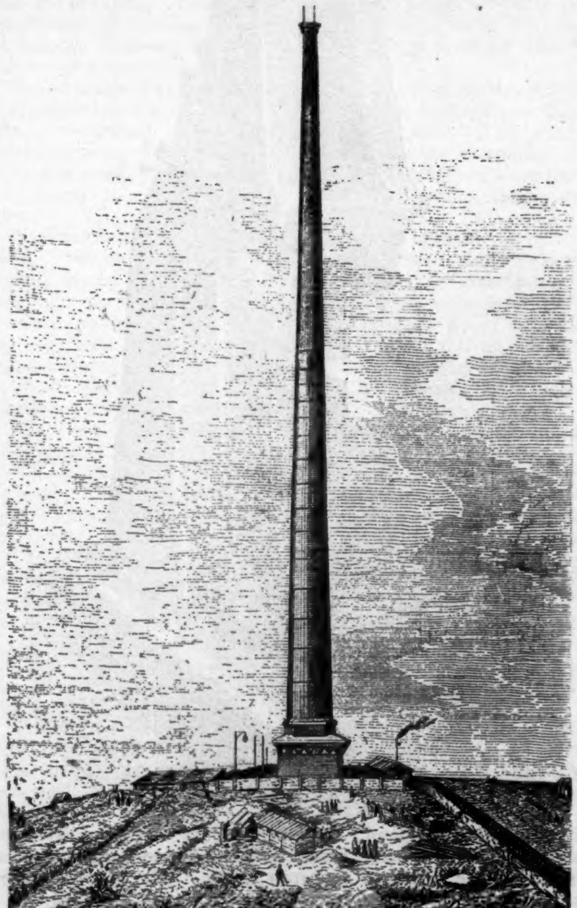
The total cost of this lighthouse was about $11,800. It was designed by MM. B. Bernard, Director of the Lighthouse Service, and A. Bourdelle, Chief Engineer of the same service.

**New Steamers for the Pacific.**—The Naval Construction & Armament Company of Barrow, Eng., recently took a contract to build three steamers for the Canadian Pacific Railroad Company. These steamers are to have twin screws, to be 440 ft. long and of 7,000 tons measurement, and to attain a speed of 18 knots. They are intended to run between Vancouver, the Pacific terminus of the railroad, and Yokohama.

The Canadian Pacific Company has also received bids for three steamers, 480 ft. long, 54 ft. beam, and 25 ft. draft; to have single screws and to be capable of a speed of 20 knots. These steamers are also intended to run in connection with the railroad; but on the Atlantic side, from some English port to Quebec in the summer and to Halifax in the winter. The two lines of steamers on the Atlantic and Pacific, wth the railroad, will form a through line from England to Japan and China, by which quicker time it is expected will be made than by any other route.

**A Great Chimney.**—The great chimney recently built at Fall River, Mass., which is 340 ft. in height, will be far surpassed by one now under construction at the Imperial Foundry of Halsbrücke, near Freiburg in Saxony, which is intended to carry the noxious gases from the furnaces to such a height in the air as to prevent any inconvenience to the surrounding country. It will be 453 ft. high, with an interior diameter of 15⅜ ft. Projected and designed by the Engineer Huppner, it is built on the right bank of the River Mulde, on a hill which rises 259 ft. above the ground on which the furnaces stand, so that the top of the chimney will be 712 ft. above the works.

The base is square, measuring 39 ft. 4½ in. each way; it is 28¼ ft. high, and at its top the chimney proper begins. The works being on the left or opposite bank of the river, the flues running from the furnaces are carried across on a bridge built



for the purpose, and then up the hill to the point where they enter the chimney. The total length of these flues or ducts is 3,228 ft.

The chimney is built entirely of brick. The materials are raised by an elevator, worked by an engine which is moved from time to time as the construction increases in height.

The builder of this work is Herr Heinecke. The chimney itself will cost about $30,000, and the conducting flues and other work as much more. The accompanying cut is a general view of the chimney as it will appear when finished.—*Le Genie Civil.*